

NO. 5 CROSSBAR SWITCHING SYSTEM WIRE SPRING RELAY CIRCUIT

VOLUME 1

TEXT OUTLINE



PRINTED
IN
U.S.A.

March 1955

No. 5 Crossbar Switching System
Wire Spring Relay Circuit

Volume 1

Text Outline



Printed
in
U.S.A.

March, 1955

VOLUME I - WIRE SPRING NO. 5 CROSSBAR SYSTEM

TABLE OF CONTENTS

- Section 1 - General Description of the Wire Spring
No. 5 Crossbar System
- Section 2 - Dial Tone Job
- Section 3 - Dialing the Called Number
- Section 4 - Pretranslation
- Section 5 - Intraoffice Call
- Section 6 - Outgoing Calls Using Senders
- Section 7 - Incoming Call

GENERAL DESCRIPTION

NO. 5 CROSSBAR WITH

WIRE SPRING CIRCUITS

CONTENTS	PAGE
1. INTRODUCTION	5
2. SWITCHING PRINCIPLES	7
A. General	7
B. Major Switching Frames	8
General	8
Line Link Frames	9
Junctors	11
Trunk Link Frames	11
Channels	13
3. EQUIPMENT ELEMENTS	14
A. General	14
B. Line Link Frames	14
C. Trunk Link Frames	14
D. Extension Trunk Link Frames	14
E. Junctor Grouping Frame	14
F. Markers	14
G. Originating Registers	16
H. Pretranslators	17
I. Number Groups	17
J. Outgoing Senders	17
K. Outgoing Sender Links	18
L. Incoming Registers	18
M. Incoming Register Links	19
N. Intermarker Group Senders	19
O. Connectors	19
P. Trunks	21
Q. Coin Supervisory Circuits	22
R. Coin Supervisory Links	23
S. Message Register Frames	23
T. Foreign Area Translators	23
4. METHOD OF OPERATION	23
A. General	23
B. Noncoin Calls Excluding Message Charging	25
Dial Tone Connection	25
Establishing Dialing Connection	25

CONTENTS

PAGE

Pretranslation	27
Intraoffice Calls	27
Interoffice Calls - Outgoing	30
Interoffice Calls - Incoming	31
Reverting Calls	32
Assistance and Service Code Calls	33
Manual Calls	34
Dialing Into An Adjacent Area	34
Various Call Conditions	35
 C. Message Charging On Coin and Noncoin Calls	 37
Prepayment Coin Service	37
Message Register Service	39
AMA Service	40
 D. Operation of No. 5 Crossbar Office With Combined Toll and DSA Switchboard	 41
E. Operation of No. 5 Crossbar Office With DSB Switchboard	44
F. No. 5 Crossbar Office With Tandem Switching Features	45
G. No. 5 Crossbar Office With Toll Center Switching Features	47
H. Multioffice Operation	49
I. Physical-Theoretical Office Operation	49
J. Intermarker Group Operation	50
K. Direct and Alternate Route Arrangements in the No. 5 Crossbar System	 53
L. Operator Junctor Operation	54
M. Coin Junctor Operation	55
N. AMA Junctor Operation	55
O. Selection Preference	56
P. Code Conversion	57
Q. Calls Involving Equipment Irregularities	57
 5. EQUIPMENT ARRANGEMENTS	 59
 6. MAINTENANCE FEATURES	 59
A. General	59
B. Test Set-type Testing Arrangements for Registers and Senders	 62
C. Electronic Pulse Generator	63
D. Testing Equipment for Subscriber Message Registers	63
E. Arrangement for Testing Subscriber Station Ringers	64
F. Central Office Alarm System	64
G. Automatic Line Insulation Test Equipment	65
 7. GLOSSARY	 65

FIGURES

- 1 - Partial Perspective View of 20-vertical Unit Crossbar Switch (200 Point)
- 2 - Equipment Schematic of a No. 5 Crossbar Office
- 3 - Line Link Frame
- 4 - Line Link Distribution
- 5 - Junctor Distribution (4 Line Links and 2 Trunk Link Frames)
- 6 - Pairing of Trunk Link Frames (40 Line Links and 20 Trunk Link Frames)
- 7 - Trunk Link Frame
- 8 - Trunk Link Distribution
- 9 - Switch Arranged for 16 Trunk Appearances on Trunk Link Frame
- 10A- Channels for 20 Line Links - 10 Trunk Link Frames
- 10B- Channels for 10 Line Links - 5 Trunk Link Frames
- 11 - Line Link Frames and the Association of Basic and Supplementary Bays
- 12 - Trunk Link Frame
- 13 - Junctor Grouping Frame
- 14 - Marker Frame - Common Equipment Frame
- 15 - Marker Frame - Translator and Code Treatment Frame
- 16 - Marker Frame - Route Relay Frame
- 17 - Marker Frame - Dial Tone Marker
- 18 - PBX Allotter Frame
- 19 - Originating Register and Originating Register Line Memory Frame
- 20 - Dial Pulse and Multifrequency Incoming Register Frames
- 21 - Pretranslator and Pretranslator Connector Frame
- 22 - Number Group Frame
- 23 - Outgoing Sender Frame
- 24 - Register and Sender Link Frames
- 25 - Tandem Revertive Pulse Incoming Register Frame
- 26 - Marker Connector Frames

FIGURES

- 27 - Connector Frames
- 28 - Foreign Area Translator Connector Frame
- 29 - Trunk Relay Rack
- 30 - Message Register Frames
- 31 - Foreign Area Translator Frame
- *32 - Dialing Connection
- *33 - Intraoffice Trunk Connection
- *34 - Reverting Trunk Connection
- *35 - Outgoing Trunk Connection
- *36 - Incoming Trunk Connection
- 37 - Establishing Dialing Connection
- 38 - Line Link Frame Schematics (Wiring Side)
- 39 - Establishing Intraoffice Trunk Connection
- 40 - Establishing Outgoing Trunk Connection
- 41 - Establishing Incoming Trunk Connection
- 42 - Establishing Reverting Trunk Connection
- 43 - Establishing Toll and DSA Operator, Service Code, or Manual Trunk Connection
- *44 - Association of Coin Trunk and Coin Supervisory Link
- *45 - Intervals for Coin Operation With Overtime
- *46 - Traffic at a Combined Toll and DSA Switchboard Associated With a No. 5 Crossbar Office
- 47 - Call From a Toll and DSA Switchboard Completed to No. 5 Crossbar Subscriber
- 48 - Outgoing Call From Toll and DSA Switchboard (Pulse Conversion)
- 49 - Operation of No. 5 Crossbar Office Associated With DSB Switchboard

* Indicates inserted figure.

FIGURES

- 50 - Tandem Center Switching Combined With Local Completion to Subscribers in the Same Marker Group
- 51 - Toll Center Switching Combined With Local Completion to Subscribers in the Same Marker Group
- 52 - Intermarker Group Trunk Connection - Subscriber to Subscriber
- 53 - Intermarker Group Trunk Connection - Subscriber to Trunk
- 54 - Intermarker Group Trunk Connection - Trunk to Subscriber
- 55 - Call From a Toll and DSA Switchboard Associated With a No. 5 Crossbar Office to a Connecting Office
- 56 - Coin Junctor Operation
- 57 - Master Test Frame - Recorder, Control, and Jack Bays
- 58 - Master Test Frame - Automatic Monitor, Register, and Sender Test Bays
- 59 - Master Test Connector Frame
- 60 - Trouble Recorder Cards
- 61 - Line Insulation Test Frame

1. INTRODUCTION

- 1.01 (a) This section describes in a general way, the wire spring version of the No. 5 crossbar telephone switching system. It complements Section 971.501.01 which describes the nonwire spring version of the No. 5 crossbar system. The system is being revised to use wire spring and dry reed type relays as well as improvements in circuit design. The use of the new relays has allowed a reduction of equipment space in most of the circuits. The method of presenting the circuit material has been changed. For the wire spring No. 5 crossbar system, the schematic diagrams have been drawn in a detached contact manner. The circuits are divided into functional schematic figures and are printed on 11 x 22 inch. sheets with the other material usually found on schematic drawings. These new type drawings are described in Section 950.701.01.
- (b) The essential features of the wire spring No. 5 crossbar system are the same as the nonwire spring system. In fact, most wire spring No. 5 crossbar circuits are functionally interchangeable with their nonwire spring counterparts.
- (c) Both the wire spring and nonwire spring No. 5 crossbar systems can interconnect with many different types of equipment. This feature makes its use attractive in areas on the outskirts of large cities where it is necessary to complete calls to the metropolitan offices as well as

to varieties of outlying suburban offices. The flexibility of the system permits its use, economically, in small offices, as well as in larger offices. It can be introduced in any area without major changes in existing step-by-step, panel, or No. 1 crossbar offices and without changes in existing dial telephone instruments. This system can interconnect directly with all present local, tandem, and toll offices, except that it cannot direct traffic to distant office tandem (panel 2-wire office selectors).

1.02 The following are some of the highlights of this system:

- (a) Common Control: The control of switching the traffic in an office is concentrated in certain equipment units which are common to all frames. An advantage of common control operation is that only a few circuits need be provided to set up the connection. These can be equipped with self-checking and service safeguarding features. The cost of these features would be prohibitive if many circuits were involved.
- (b) Methods of Charging: Automatic message accounting (AMA) is especially well suited for operation with the No. 5 crossbar system. This method takes a permanent record of charge data on paper tape and requires very little manual operation. (For a complete description, see X-63915, No. 5 Crossbar System - AMA Features.) Message register and coin service can also be provided by the No. 5 system; however there is no zone registration or coin zone dialing.
- (c) Maintenance: This system is more self-checking than other present systems. The marker (a unit of common control equipment) has access to most of the elements in an office, and it is able to gather information from many sources on the performance of the different parts. It can automatically refer to the maintenance force information about trouble conditions. When a trouble is encountered, a trouble recorder makes a permanent record on punched cards which are used by the maintenance force in locating trouble. Most of the testing equipment is mounted on several bays which are called the master test frame.

1.03 This system can handle the dialing of directory numbers consisting of four to eight digits. It also can handle up to eleven digits for any extension of subscriber and operator dialing outside of the home numbering plan area. Sixty classes of service are provided, including coin and noncoin, flat rate and message rate, individual and party lines (see Glossary).

1.04 Tandem and toll center switching features can be provided in a No. 5 crossbar office. Such an office acts as a toll and tandem traffic center as well as a local office.

1.05 This system can operate with present dial systems with their particular types of pulsing: dial, revertive, or multifrequency. However, because multifrequency pulsing is faster than other types of pulsing, it is used by the No. 5 office whenever practical. Table A shows the usual kinds of pulsing or manner of operation for the various combinations of No. 5 crossbar and connecting offices. When more than one type of pulsing is available, the preferred type is shown first.

Table A

<u>Type of Pulsing Received From No. 5 Crossbar Office</u>	<u>Type of Office</u>	<u>Type of Pulsing Sent to No. 5 Crossbar Office</u>
Multifrequency (MF) Dial (DP) Revertive (RP)	No. 5 Crossbar	Multifrequency (MF) Dial (DP) Revertive (RP)
Multifrequency (MF) Revertive (RP) Dial (DP)	No. 1 Crossbar	Revertive (RP) Multifrequency (MF)
Revertive (RP)	Panel	Revertive (RP)
Dial (DP)	Step-by-Step	Dial (DP)
Panel Call Indicator (PCI) Straightforward (Nonpulsing) Step-by-Step Call Indicator (DP)	Manual	Multifrequency (MF) Dial (DP) Straightforward (Via DSB Switchboard)
Panel Call Indicator (PCI)	Panel Sender Tandem	Revertive (RP) Dial (DP)
Multifrequency (MF) Dial (DP)	Crossbar Tandem	Multifrequency (MF) Dial (DP) Revertive (RP)
Multifrequency (MF) Dial (DP)	No. 4-type Toll (Crossbar)	Multifrequency (MF) Dial (DP) Revertive (RP)
No Provision	Panel Distant Office Tandem (2-way Office)	Revertive (RP)

2. SWITCHING PRINCIPLES

A. General

2.01 This part describes the means which the No. 5 crossbar system uses to give its customers telephone service. The switching principles are explained in terms of the switching frames. Before these switching principles are discussed, however, a short description is given of the operation of the crossbar switch which is fundamental to the understanding of this system.

2.02 The basic element in any crossbar system is the crossbar switch which also gives the system its name. Talking connections through switching frames are made by crossbar switches.

2.03 The crossbar switch is essentially a relay mechanism consisting of ten horizontal paths and ten or twenty vertical paths, depending on what size switch is needed. Any horizontal path can be connected to any vertical

path by means of magnets. The points of connection are known as crosspoints. The switch with ten vertical paths has 100 crosspoints and is called a 100-point switch; the one with twenty vertical paths has 200 crosspoints and is called a 200-point switch. Fig. 1, attached, shows a partial perspective view of a crossbar switch.

2.04 Horizontal Paths: There are five selecting bars mounted horizontally across the face of each switch. Each selecting bar has flexible selecting fingers attached to it, one finger for each vertical path, and the bars can be rotated slightly to cause the select fingers to go either up or down under control of select magnets. This forms two horizontal paths per bar, making a total of ten horizontal paths.

2.05 Vertical Paths: Ten or twenty vertical units are mounted on the switch and each unit forms one vertical path. Each unit operates under control of a hold magnet and has ten groups of contacts (one for each horizontal path) associated with it.

2.06 Each group of contacts may consist of three to six pairs of contact springs. A switch is classified according to the number of crosspoints and pairs of springs; for example, a 200-point, 3-wire crossbar switch.

2.07 Operation of the Crossbar Switch: The normal position of the selecting fingers is horizontal, lying between two groups of contacts. When a select magnet operates, the selecting bar is rotated and one of the horizontal paths available to this bar is chosen. The selecting fingers now lie in front of a group of contacts.

2.08 The hold magnet of the vertical path to be connected to this horizontal path then operates its holding bar which, using the selecting finger as a wedge, causes the group of contacts beside the selecting finger to operate, thus connecting the horizontal and vertical paths. Both the select and hold magnets must be operated in order to close a crosspoint. The other groups of contacts on this vertical unit do not operate since there is no selecting finger between them and the holding bar.

2.09 After the operation of the hold magnet, the select magnet releases, re-turning the horizontal bar and all but one of the selecting fingers back to normal. The finger used to establish the connection, being flexible, remains wedged against the contacts by the holding bar and in this way keeps the contacts operated. When the hold magnet releases, the connection is released and the selecting finger returns to normal.

B. Major Switching Frames

General

2.10 All connections in the talking path to No. 5 crossbar subscribers are established through two kinds of switching frames; line link frames and trunk link frames. The subscriber lines are connected to the switches on the line link frames, and the various trunks and register circuits are connected to the switches on the trunk link frames. These frames interconnect over junctors that are attached to junctor switches which appear on the line link and trunk link frames. These switching operations are controlled by control equipment which includes markers and associated connectors.

2.11 Fig. 2, attached, is a simple diagram showing the relationship of the switching frames and the common control equipment.

Line Link Frames

General

2.12 The crossbar switches on the line link frame are divided functionally into line switches and junctor switches. Subscriber lines are connected to the line switches and junctors to the junctor switches. Line links, which are merely connecting wires, are provided for interconnecting the line switches and junctor switches; hence the name line link frame. Fig. 3 is a simple diagram of a line link frame.

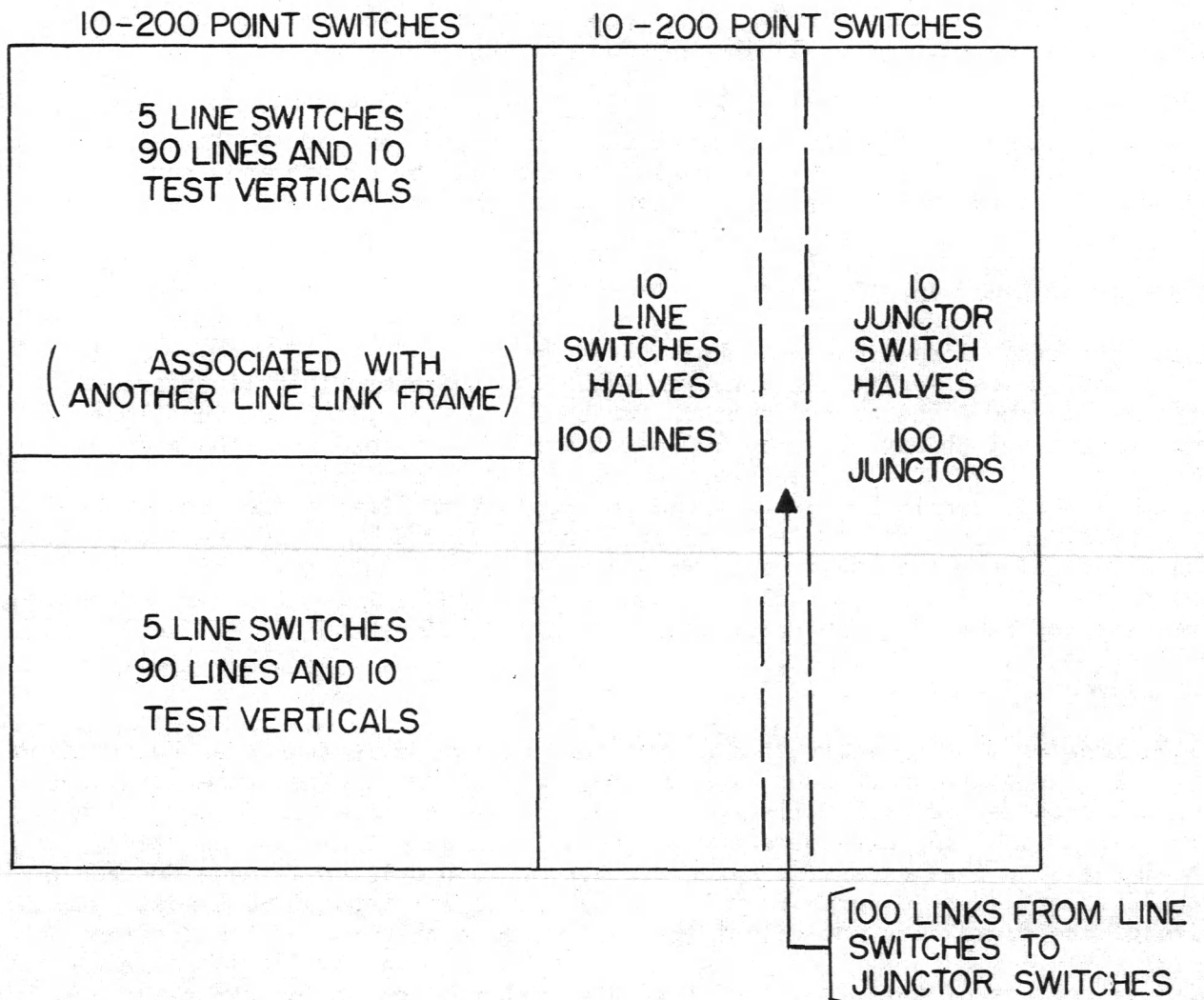


Fig. 3 - Line Link Frame

Line Switches

2.13 The basic line link frame is a 2-bay framework of switches and relays. There are ten 200-point crossbar switches on each bay. Half of each switch on one bay is used for junctor locations, while the other halves are

used as line switches for subscriber's use. The second bay of switches is also divided. One half of the bay is associated with one line link frame; the other belongs to another line link frame. These switches are used for subscriber's appearances. Each vertical on a line switch is used for a subscriber line except one which is used for no-test access to the others. An advantage of using a vertical for a subscriber's line is that the off-normal springs of the hold magnet can be used as a cutoff relay. The line relays, one for each subscriber line, are mounted at the top of the line link frame.

2.14 Line links appear on the horizontals of the switches; ten line links on each switch. These ten line links are distributed among the ten junctor switches, one line link to one horizontal on each of the ten junctor switches. This system of line links permits each line on a line link frame to reach any one of the 100 juncctors serving that frame. Fig. 4, attached, shows how each line switch has access to all the junctor switches.

2.15 Any particular line link can be readily traced by the following method. The number of the horizontal on the line switch end of the line link is the same as the number of the switch on the junctor switch end, and the number of the horizontal on the junctor switch end is the same as the number of the switch on the line switch end.

Capacity of Line Link Frames

2.16 The basic line link frame has a capacity for 190 subscriber verticals and 10 test verticals. The verticals for the subscriber lines are arranged on the crossbar switches in two bays. One bay, the combined line and junctor switch bay, has ten 200-point switches divided down the middle. One half - 100 verticals - is provided for junctor terminations while the other half, also 100 verticals, is provided for subscriber lines. The remaining 90 subscriber lines and 10 test verticals are arranged on an adjacent bay of ten 200-point crossbar switches. This bay is divided into two halves, top and bottom. If the bottom half belongs to the line link frame under discussion, then the top half, another group of 90 subscriber lines and 10 test verticals, will belong to another line link frame. See Fig. 3 for a sketch of this arrangement.

2.17 Greater line capacity than is provided by the basis frame can be obtained by the addition of supplementary bays of switches. The number of lines which can be served by 100 links, and therefore by a frame, is determined by the average incoming plus outgoing usage (calling rate times holding time) of the lines. To take care of varying requirements, provision is made for adding supplementary bays to serve from 190 to 590 lines in steps of 50 lines. The size of the frame does not affect the following description of its functions.

2.18 A feature of this line link frame is that the same frame can serve customers who have various classes of service; for example, coin, flat-rate, and message-rate customers can have their lines all terminating on the same frame. A maximum of sixty classes of service can be served on a frame and this is also the maximum that can be served by one marker group. However, the number of line switch verticals may be less than the number of classes of service (sixty) so that not all classes of service will be available on one line link frame at one time.

Junctors

- 2.19 Each line link frame has 100 junctor terminations which are used to connect to all the trunk link frames in the office. Since each trunk link frame has 200 junctor terminations for connecting to all line link frames, the ratio of line link frames to trunk link frames in an office generally is 2:1. There are no half frames. (In an office with thirteen line link frames, there are usually seven trunk link frames.) However, conditions peculiar to a particular office may cause some variation in this ratio.
- 2.20 The 100 junctors from each line link frame are divided into approximately equal groups, with one group from each line link frame going to each trunk link frame. The number of junctors in a group depends on the number of trunk link frames in the office. The number of junctors per group is determined by dividing the 100 junctors by the number of trunk link frames. However, there is a limiting factor; no group can contain less than ten junctors.
- 2.21 When there are ten or fewer trunk link frames in an office, each junctor group has ten or more junctors; for example, in an office with eight trunk link frames and sixteen line link frames, each junctor group contains either twelve or thirteen junctors. Fig. 5, attached, illustrates the junctor distribution for two trunk link frames and four line link frames.
- 2.22 However, in an office with eleven to twenty trunk link frames, each junctor is multiplied to two trunk link frames in order to have at least ten junctors per group; for example, in an office with twenty trunk link frames and forty line link frames, each junctor group contains ten junctors. Fig. 6, attached, illustrates the junctor distribution for twenty trunk link frames and forty line link frames. In this case, the number of junctors in a group is determined by dividing 100 by the number of pairs of trunk link frames.

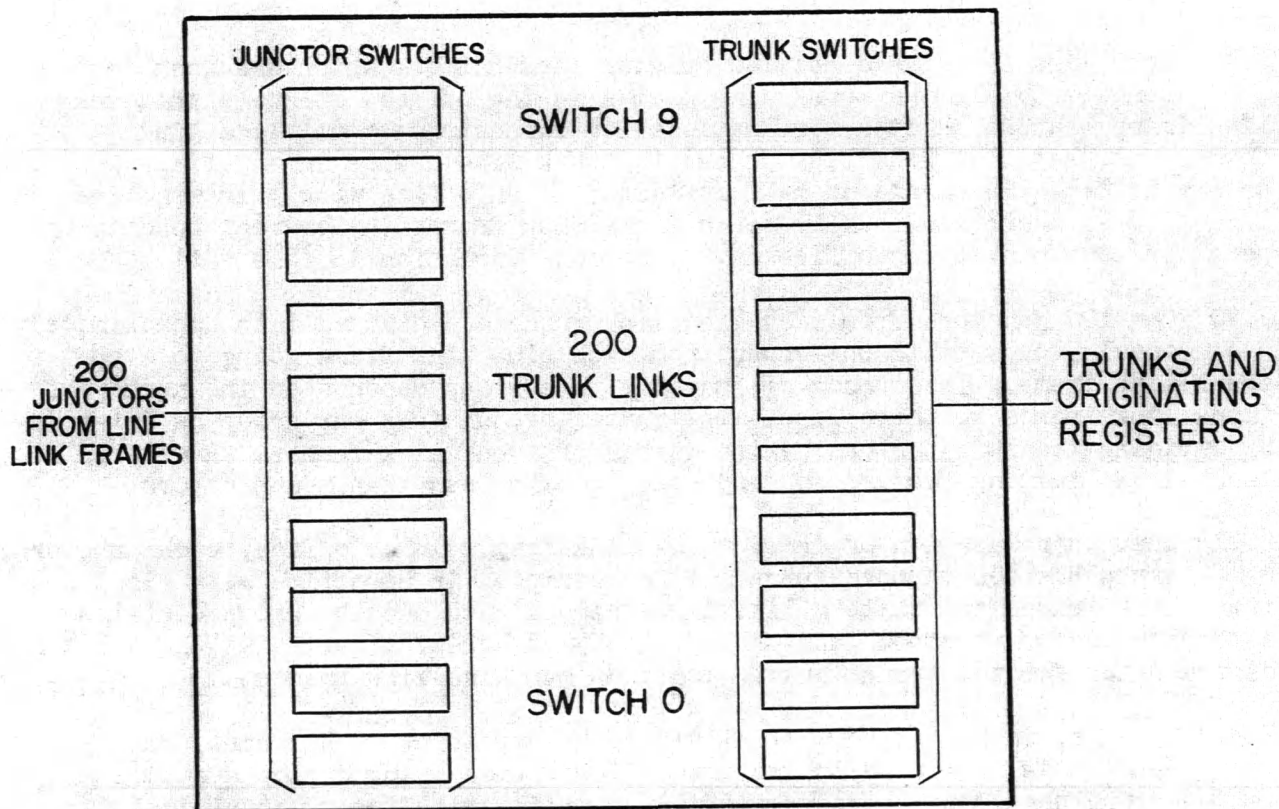
Trunk Link Frames

General

- 2.23 The trunk link frame is made up of trunk switches, junctor switches, and various miscellaneous circuits. Trunks and originating registers (which register the called number) are connected to the trunk switches. The junctors from the line link frame are connected to the junctor switches. The trunk and junctor switches are interconnected by trunk links which are similar to line links. The trunk links go from the junctor switch verticals to the trunk switch verticals; line links are connected horizontal-to-horizontal. A diagram of a trunk link frame is shown in Fig. 7.

Trunk Links and Junctors

- 2.24 The system of trunk links that permits any trunk on a trunk link frame to be connected to any one of the 200 junctors serving that frame is similar in principle to that used on line link frames. The number of trunk links, which is 200, is the same as the number of junctors. The trunk links run from vertical to vertical, the junctors being connected to the horizontals of the junctor switches and the trunks to the horizontals of the trunk switches.



*Fig. 7 - Trunk Link Frame

In order to terminate twenty junctors on the horizontals of one 200-point switch, it is necessary to split the horizontal multiple into a left-hand and a right-hand half-switch. The two half-switches thus formed are treated separately and the numbering of the verticals in each half is similar, but they are identified as left and right. Although the trunk switches are not physically split, the numbering of verticals is also on a left and right basis.

2.25 The trunk link distribution is similar to that provided for the line link distribution. The vertical number at one end of a link is always the same as the switch number at the other end of the link. In addition, a vertical on the left half of a switch is always connected to a vertical on the left half of the switch at the other end of the link, and a vertical on the right half of a switch is always connected to a vertical on the right half of the switch at the other end of the link. (See Fig. 8, attached.)

Extension Trunk Link Frame

2.26 When eleven to twenty trunk link frames are involved, each junctor is multiplied to two trunk link frames in order that each junctor group contain a minimum of ten junctors. This requirement reduces the junctor capacity of the basic trunk link frames by 50 per cent, and it is necessary to provide additional junctor switches for each trunk link frame. These additional switches are mounted on the extension trunk link frame which,

if equipped initially, is placed adjacent to the junctor switch bay of the trunk link frame. The extension frame consists of a framework with ten 200-point, 3-wire switches the same as the junctor switches on the trunk link frame. These switches have a capacity for 200 junctors which, with the 200 junctors on the trunk link frame, provide a total of 400 junctors for the combination.

Trunk Switches

2.27 The ten trunk switches on the trunk link frame are 6-wire switches.

They furnish locations for 160 trunks. Each switch has locations for sixteen trunks on eight of its levels (horizontals). Fig. 9, attached, illustrates how this is accomplished.

2.28 The 6-wire switches are so arranged that each one of levels 2 to 9 terminates on two 3-wire trunks. One trunk on each level is connected to one set of three wires of the horizontal multiple and designated appearance A, and the other trunk to a second set of three wires and designated appearance B.

2.29 The trunk link is wired to the first three nonmultiple terminals of level 1 and the last three nonmultiple terminals of level 0. Each operation of the trunk switch requires two select magnet operations. Either 0 or 1 select magnet must be operated to direct the trunk link to the proper 3-wire connection of the vertical, and in addition, the select magnet associated with one of the levels 2 to 9 where the trunk appears must be operated. The levels 0 and 1 are directing levels. The eight appearances on each switch that are selected by horizontal 0 are called A appearances and those selected by horizontal 1 are called B appearances.

Channels

2.30 A channel is a combination of a line link, a junctor, and a trunk link that can be formed, by crosspoint closures, into a chain that interconnects a line and a trunk. Each line link, junctor, and trunk link consists of a tip, ring, and sleeve lead with a switch appearance at each end.

2.31 The ten or more junctors in a group connecting a line link frame with a trunk link frame are distributed over the ten junctor switches of both the line link and trunk link frames, the junctor switch number being the same on both ends for each junctor. There are ten line links serving each particular subscriber line on the line link frame, and these are also distributed over the ten junctor switches.

2.32 There are twenty trunk links serving each particular trunk on the trunk link frame, and these are also distributed over the ten junctor switches. Thus, when a particular line and a particular trunk for a unit consisting of, for example, twenty line link and ten trunk link frames are considered, there are ten channels available for a connection. These channels are numbered according to the junctor switches on which they terminate, as illustrated in Fig. 10A, attached. An idle channel is selected by testing the ten channels at the same time. For job sizes other than the above, there are more than ten channels available. For example, in a 10-line link and 5-trunk link frame

job, there are twenty channels provided, as illustrated in Fig. 10B, attached. In these cases, additional tests are made when an idle channel is not found in the first ten channels tested.

2.33 It will be seen that the channel number also corresponds to the number of the line switch horizontal on which the line link appears, as well as the number of the trunk switch vertical on which the trunk link appears.

3. EQUIPMENT ELEMENTS

A. General

3.01 The functions and physical appearance of the main equipment elements in a No. 5 crossbar office are briefly described in this part.

B. Line Link Frames

3.02 Line link frames contain subscriber line appearances. All calls to or from a subscriber go through the line link frame. These frames also contain access leads for tandem, toll, and intercept trunks and test lines.

3.03 Fig. 11, attached, shows a 2-bay line link frame for 290 lines with combined line and junctor switches in one bay and line switches in the other.

C. Trunk Link Frames

3.04 Trunk link frames are 2-bay frames which contain the access leads for originating registers and trunks. Fig. 12, attached, shows this frame.

D. Extension Trunk Link Frames

3.05 Extension trunk link frames are one-bay junctor switch frames and correspond to the junctor switch bay shown in Fig. 12, attached. When extension frames are required, there is one for each trunk link frame.

E. Junctor Grouping Frame

3.06 Fig. 13, attached, shows the junctor grouping frame. It is a one-bay frame consisting of terminal strips, fanning rings, and rings for jumpers. The junctor grouping frame provides means for terminating the junctor ends which originate at the line link frames and trunk link frames, and for cross-connecting these terminations so that equal access to all trunk link frames is obtained by all line link frames.

F. Markers

3.07 The marker is the most active piece of common control equipment in the office. It is used one or more times in the completion of every call. Different offices have various numbers of markers depending on the size of the office and the amount of traffic. All the markers and their associated equipment serving up to a maximum of 20,000 numbers make up a marker group.

3.08 There are two types of markers: dial tone and completing. The dial tone marker is used on dial tone jobs and the completing marker performs all the other jobs.

3.09 The principal functions of the dial tone marker are:

- (a) It responds to demands for dial tone by determining the location of the calling line on the line link frame and establishing a connection from the calling line to an originating register. It passes the calling line location and subscriber class-of-service information to the originating register. The register stores this information, and after dialing is completed, passes it back to a completing marker to establish the connection.

3.10 The principal functions of the completing marker are:

- (a) To determine the proper route for the call from the office code digits of the called number and the class of service of the calling subscriber.
- (b) To establish the connection from a calling subscriber to a trunk or from a trunk to a called subscriber.
- (c) To connect to the proper number group to learn the location of the called line on the line link frame.
- (d) To determine from the class of service and the destination the proper charge condition for the call.
- (e) When outgoing pulsing is required, to select an outgoing sender of the proper type. The marker then passes information to the sender which the sender transmits when the connecting office equipment is ready.
- (f) To recognize line busy, vacant numbers, and intercept conditions, and to control hunting operation in terminal hunting groups.
- (g) To complete a call under certain trouble conditions.
- (h) To call in the trouble recorder which makes a record of the marker progress if its operation is abnormally delayed or if there are certain trouble conditions.

Special Features in the Marker

3.11 Two markers (0 and 1) in a group of completing markers are usually equipped with special features for handling certain test calls. These calls are set up by operators, testmen, or maintenance men and are of the following types:

- (a) No-test calls originated at the test desk or a DSA switchboard.
- (b) No-hunt calls originated at the outgoing trunk test frame or the message register rack.
- (c) Special hunt test calls originated at the local test desk.

The regular subscriber line tests (ground and continuity) which are performed by the marker during normal operation are cancelled on all these calls.

3.12 The marker normally completes each of its various functions in less than one second. Therefore, a small number of markers can serve a large office.

3.13 Each completing marker is made up of the following frames:

Common equipment frame designated COM EQPT. (See Fig. 14, attached.)

Translator and code treatment frame designated T & CT. (See Fig. 15, attached.)

Route relay frame designated RR. (See Fig. 16 attached.)

3.14 Some of the features available in the No. 5 crossbar system require that an equipment frame be added to the completing marker when the feature is used. These frames are the following:

(a) PBX allotter frame. (See Fig. 18, attached.) A basic frame designated PBX ALLR serves eight markers and four PBX's. A supplementary frame designated SPBX ALLR serves eight markers and six PBX's. The feature is described under B (Intraoffice Call - Terminal Hunting), Method of Operation.

(b) A code conversion frame to augment the translator frame if all code conversion equipment cannot be placed on the translator frame.

3.15 Each dial tone marker is made up of a common equipment frame. See Fig. 17 attached.

3.16 The marker frames are cross-connected through terminal strips. This method of assigning marker cross connections simplifies making changes and insures flexibility of connections.

G. Originating Registers

3.17 Originating registers furnish dial tone to subscribers and record the digits that are dialed. After dialing is completed, the called number is transmitted from the register to a marker. These registers also make party test to determine whether a tip or ring party is making the call. Originating registers appear on trunk link frames and one is connected to the subscriber's line by the dial tone marker when the customer lifts the receiver off the hook.

3.18 A No. 5 crossbar office which includes any coin lines must have all the originating registers in the office arranged for coin operation.

3.19 There are eight registers on each originating register frame. This 2-bay frame is designated OR. (See Fig. 19 attached.) The relays in the originating register circuit which are used to store the subscriber's line location during dialing, are located on an originating register line memory frame. There is room on this frame for the memory and connector relays of twenty-four originating registers. (See Fig. 19, attached.)

H. Pretranslators

3.20 Pretranslator circuits may be provided in offices located in areas where some calls require the dialing of more digits than others. The originating register circuit may be arranged to seize the pretranslator after either the second or third digit has been dialed. From these digits, the pretranslator determines how many more digits the register should expect before seizing a marker.

3.21 The pretranslator frame is a single-bay frame with space for two pretranslators and two pretranslator connectors. (See Fig. 21, attached.) If another pretranslator is necessary, a second frame is provided for one pretranslator and its connector. Two pretranslators are adequate for most marker groups. The arrangements provide for one pretranslator group to serve two marker groups when desired.

I. Number Groups

3.22 The number group translates subscriber directory numbers into line equipment locations of subscriber lines. (The line equipment location identifies the line link frame location of a subscriber line.) The number group also supplies the proper ringing control information and other information concerning the called number, such as whether it is in a terminal hunting group or in a physical or theoretical office.

3.23 A number group frame serves 1000 consecutive directory numbers. (See Fig. 22, attached.) For example, number group frame 1 contains directory numbers whose numerals are 1000 to 1999. Therefore, the total amount of directory numbers, in multiples of 1000, to be equipped, determines how many number group frames are required. A maximum of twenty number group frames, exclusive of trunk number frames, can be associated with one marker group.

J. Outgoing Senders

3.24 An outgoing sender is employed on all calls requiring pulsing to connecting offices. The marker transfers the required digits of the called number to a sender which is connected to an outgoing trunk. The function of the sender is to furnish the pulses which control the operation of the switching equipment in the connecting office. The type of connecting office (step-by-step, panel, manual, or crossbar) determines what kind of sender should be used to transmit the called number. Therefore, four different types of outgoing senders are provided in a No. 5 crossbar office, as listed below:

- Dial pulse (DP)
- Multifrequency (MF)
- Revertive pulse (RP)
- Panel call indicator (PCI)

3.25 The outgoing sender frame mounts three senders of one type. (See Fig. 23, attached.)

3.26 The multifrequency outgoing sender requires an ac supply of six different frequencies. These are used in various combinations of two each for the digits 0 to 9 and the start and end signals. This ac supply may be a separate

one for all senders, or it may be made a part of each sender if transistor oscillator's are used.

K. Outgoing Sender Links

3.27 Outgoing sender links connect outgoing and intermarker group senders to outgoing trunks. Information from a sender to a trunk is transmitted through this sender link.

3.28 One sender link frame (designated OSL) mounts ten 200-point crossbar switches. (See Fig. 24, attached.) The four types of outgoing senders, MF, DP, RP, PCI, and intermarker group senders may be located on one sender link frame.

L. Incoming Registers

3.29 Incoming registers record the pulses on calls received over incoming trunks from operators or connecting offices. Since these pulses are incoming from various types of offices, the following different incoming registers are provided to record them:

(a) Dial pulse (DP).

(b) Multifrequency (MF).

(c) Revertive pulse (RP). There are three types of revertive incoming registers:

(1) The local revertive incoming register receives the four numerals from the originating panel or crossbar office. This register can recognize the "High Five" incoming group indication in selecting one of two terminating offices.

(2) The central B incoming register receives its digits from a central B operator's position sender on a revertive basis. The B operator receives the number from the manual A operator or toll operator on a straightforward basis.

(3) The tandem revertive pulse incoming register receives from the originating panel or crossbar equipment, office brush and office group selections in addition to the four numerals. The office brush and group selections are translated into an office code from which the marker determines the routing of the call.

3.30 Incoming registers are mounted on a single bay frame. Two revertive tandem registers can be planned on a frame while three of the same type (multifrequency, revertive, or dial pulse) may be placed on a single frame. (See Fig. 20, attached.)

3.31 Each MF incoming register has a MF receiving unit associated with it. These units receive and amplify the MF pulses and convert them into dc pulses which operate the register relays in the associated MF incoming register. These units are mounted on miscellaneous relay racks.

M. Incoming Register Links

3.32 The incoming register links connect incoming trunks to incoming registers. Information from incoming trunks to incoming registers is transmitted through these links.

3.33 (a) One link frame (designated IRL) for multifrequency and nonbylink dial pulse trunks, has eight 200-point crossbar switches on it. This arrangement allows 160 incoming trunks to be served by 10 registers. All the trunks and registers on one link frame are of one kind of pulsing. The trunk capacity of a link frame can be increased by adding one or two link frames serving 160 trunks each. These various arrangements allow 10 registers to serve 160, 320, or 480 trunks.

(b) Incoming trunks from step-by-step offices (bylink trunks) are arranged on a link frame having six 200-point switches. This arrangement serves 120 trunks. (See Fig. 24, attached.)

N. Intermarker Group Senders

3.34 The intermarker group sender is used for traffic between two different No. 5 crossbar marker groups housed in the same building. It serves in two capacities: as an outgoing sender for the calling marker and as an incoming register for the called marker.

3.35 Six senders can be mounted on the single-bay frame which is designated IMGS.

O. Connectors

3.36 A connector is a relay-type switching device for interconnecting, for a short interval of time, two equipment elements by a relatively large number of leads.

3.37 A specific method is used in naming these connectors. If more than one type of equipment can originate action toward another type, the connector is named according to both the originating and terminating action; for example, in connectors such as the line link marker connector with the word "marker" in the title, the action terminates in the marker and is originated by the line link frame. The originating circuit must be mentioned because many circuits can originate action toward the marker.

3.38 Similarly, when only one type of equipment can originate action toward another type, the connector is named according to where the connector action terminates. For this reason the connectors from markers to other frames do not contain the word "marker" in the title.

3.39 This method of naming is illustrated in the following list of principal connectors:

<u>Name of Connector</u>	<u>Connects From</u>	<u>Connects To</u>
--------------------------	----------------------	--------------------

(Connectors involving action from more than one type of source)

Line Link Marker Connector - (See Fig. 26, attached)	Line Link Frame	Dial Tone Marker
Originating Register Marker Connector - (See Fig. 26, attached)	Originating Register	Completing Marker
Incoming Register Marker Connector - (See Fig. 26, attached)	Incoming Register	Completing Marker

(Connectors involving action from only one type of source)

Line Link Connector - (See Fig. 27, attached)	Dial Tone and Completing Marker	Line Link Frame
Trunk Link Connector - (See Fig. 27, attached)	Dial Tone and Completing Marker	Trunk Link Frame
Outgoing Sender Connector	Completing Marker	Outgoing Sender
Number Group Connector - (See Fig. 27, attached)	Completing Marker	Number Group Frame
Pretranslator Connector - (See Fig. 21, attached)	Originating Register	Pretranslator
Foreign Area Translator Connector - (See Fig. 28, attached)	Completing Marker	Foreign Area Translator

3.40 Each connecting frame has access to each marker through one or more multicontact relays. Each relay has thirty pairs of contacts and the number of relays needed for each connector depends on the number of leads to be closed through to each marker, and also on the number of markers in the office.

3.41 Connector frames vary in their marker capacity and connecting equipment capacity. For instance the line link marker connector serves four markers while the trunk link connector serves ten markers.

3.42 The number of markers in an office varies according to traffic requirements. The largest office can have at the most, twelve markers. Since some of the connector frames can not accommodate this amount of markers, additional connector frames are provided when they are needed.

P. Trunks

3.43 Trunks appear on trunk link frames and carry calls from one office to another and from subscriber to subscriber within the office. Different types of trunks are provided to serve the various types of traffic in an office.

3.44 Trunks are mounted on relay rack frames. Those trunks which require ringing, such as intraoffice, incoming, and revertive ringing trunks, usually have ringing selection switches on the same relay rack. (See Fig. 29, attached.) Ten trunks can appear on each ringing switch.

3.45 The following is a list of principal categories of trunks. Many miscellaneous types are not listed.

3.46 Intraoffice trunks handle traffic between subscribers served by the same marker group. Each trunk requires two trunk link frame locations, an A appearance for the calling subscriber and a B appearance for the called subscriber. These trunks are usually divided into three groups: message rate (AMA or message register), flat rate, and coin.

3.47 Outgoing interlocal trunks are used to transmit calls outgoing from the No. 5 crossbar office to a connecting office. The types of outgoing trunks used depend on the traffic in an individual office. Usually, there is one group of trunks for flat-rate and message-rate traffic and another for coin traffic.

3.48 Incoming interlocal trunks carry the traffic incoming to a No. 5 office. There are two general types of these trunks; namely, nontandem and tandem. The nontandem-type trunks carry only the calls completing to subscribers in the office, and these trunks have one location in the office. This location is on the trunk link frame. The tandem-type trunks carry calls completing to subscribers in the office and also calls which are switched through when the No. 5 office functions as a tandem switching point. Tandem trunks have two frame locations in the office; one on the line link frame for switching calls through and the other on the trunk link frame for calls that terminate in the tandem office.

3.49 Two-way interlocal trunks are provided on small trunk groups when it is impractical to use one-way trunk groups. The trunks may be arranged for either loop or CX (E&M lead) signaling.

3.50 Intermarker group trunks handle traffic between two No. 5 crossbar marker groups located in the same building. The three types of trunks used for this traffic are called:

- (a) Subscriber to subscriber.
- (b) Subscriber to trunk.
- (c) Trunk to subscriber.

3.51 Operator special service and recording completing trunks are used by DSA operators to handle assistance traffic. There are usually separate groups of trunks for various classes of service.

3.52 Tone trunks are used to give line busy on intraoffice calls, overflow (paths busy), partial dial, and vacant code tones. Again there may be coin and noncoin groups of these trunks.

3.53 Common overflow trunks are provided as a final route when all permanent signal holding or noncoin combination tone trunks are busy. This trunk returns an overflow (paths busy) signal to a calling party.

3.54 Intertoll trunks are used to switch toll calls between toll centers. These trunks are of three general types as follows:

- (a) One-way incoming trunks - These have three frame locations in an office; two line link frame locations for calls switched through the No. 5 office as a toll center, and one trunk link frame location for calls terminating in the toll center.
- (b) One-way outgoing trunks - These have one trunk link frame location for calls outgoing from the No. 5 office as a toll center, and one jack location at the toll switchboard for operator-handled outgoing calls.
- (c) Two-way trunks - These have all of the locations mentioned above.

Q. Coin Supervisory Circuits

3.55 Coin supervisory circuits handle all the coin operations except those taken care of by the originating register and certain coin trunks. One of these circuits (which are in a common group and are mounted on relay racks) is connected to a trunk that is serving a coin call. The duties of this circuit are to collect the coins at the end of a completed call for which a charge is made, and to effect coin return when the call is not completed or is one for which no charge is made.

3.56 In offices with coin overtime, this circuit makes coin test and collects the coin for the initial and subsequent periods. If a deposit is not made for an overtime period, the circuit signals for an operator to come in on the connection.

R. Coin Supervisory Links

3.57 These links connect coin trunks to coin supervisory circuits. The frame is similar to the incoming register link frame and the circuit arrangements are the same.

S. Message Register Frames

3.58 Calls involving one message unit may be recorded by AMA equipment or on message registers. If message registers are used, they are mounted on message register frames.

3.59 Message registration is accomplished over a single-sleeve lead which permits line link frames with 3-wire switches to serve all classes of lines. The message register service charging arrangement involves a cold-cathode vacuum tube. Selective operation of either a tip-party or a ring-party register on 2-party lines is obtained.

3.60 Five hundred message registers and their 500 associated vacuum tubes are mounted on a message register frame as shown in Fig. 30, attached.

T. Foreign Area Translators

3.61 A foreign area translator frame and associated connectors contain circuits which operate in conjunction with the markers to permit routing calls to other national numbering areas if there is more than one trunk route available to the numbering area. Arrangements are provided for translation into a maximum of six foreign areas. Where only one route is available to each numbering area, or one combined route is available for a number of areas, the marker can route calls to them without using the foreign area translator. (See Fig. 31, attached.)

4. METHOD OF OPERATION

A. General

4.01 This part describes, without detailed reference to circuit operations, how the various types of calls in a No. 5 crossbar office are handled by this system. The operation of a No. 5 crossbar office when it is associated with combined toll and DSA switchboards and DSB switchboards, and when it has tandem or toll switching features, is also described.

4.02 The calls in a No. 5 crossbar office are of four general types: intra-office, reverting, outgoing, and incoming. A dialing connection is established in the office for the first three types of calls, as shown in Fig. 32.

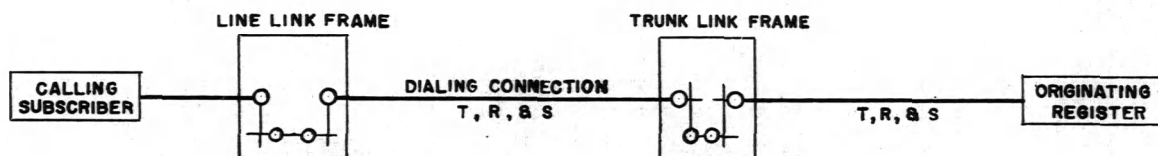


Fig. 32 - Dialing Connection

4.03 A call between subscribers with different subscriber lines who are served by the same office is an intraoffice call. The talking connection in the office consists of two channels established between the subscriber lines through an intraoffice trunk, as shown in Fig. 33.

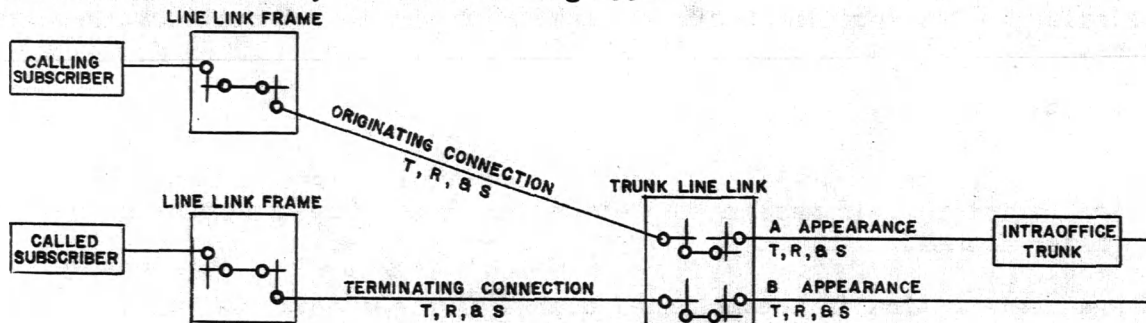


Fig. 33 - Intraoffice Trunk Connection

4.04 A reverting call is a call between two subscribers served by the same subscriber line (party line service). The talking connection consists of a channel between the subscriber line and a reverting trunk, as shown in Fig. 34.

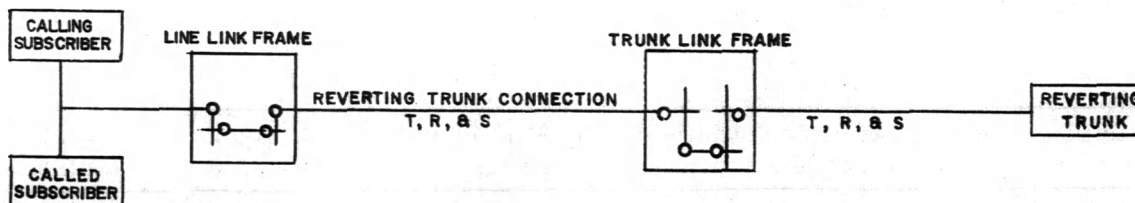


Fig. 34 - Reverting Trunk Connection

4.05 A subscriber who makes an outgoing call to another office is connected through a channel to an outgoing trunk, as shown in Fig. 35.

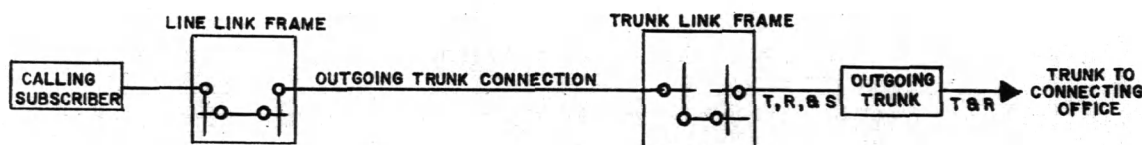


Fig. 35 - Outgoing Trunk Connection

4.06 An incoming call to a No. 5 office is connected to the called subscriber by means of a channel between the incoming trunk and the called subscriber, as shown in Fig. 36.

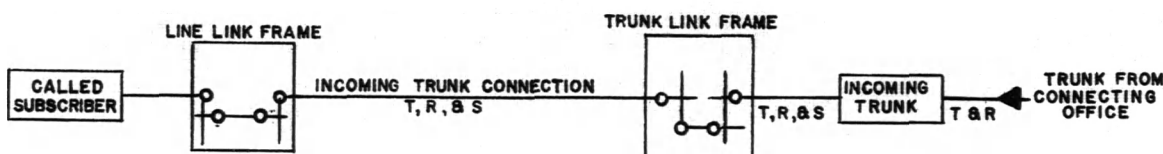


Fig. 36 - Incoming Trunk Connection

B. Noncoin Calls Excluding Message Charging

Dial Tone Connection

4.07 A dialing connection is established between the calling station and an originating register in the center office after the calling subscriber lifts the receiver from the switchhook. Dial tone, which is the signal to start dialing, is returned to the calling subscriber from the originating register.

Establishing Dialing Connection

4.08 When a subscriber takes the receiver from the switchhook, a line relay is operated which causes the line link frame to inform the line link marker connector that a marker is required. The line link marker connector selects an idle marker; it then transmits to this marker the identity of the calling line. The only time the line link marker connector seizes a marker is when a dialing connection is to be established. (See Fig. 37, attached, connection 1.)

4.09 In order to establish a dialing connection between the subscriber line and an idle originating register, the marker must determine:

- (a) The class of service and equipment location of the calling line; that is, the line link frame number and the location of the line on that frame.
- (b) Whether an idle register is available and the number of the trunk link frame on which it appears.
- (c) That a channel between the line and the register can be obtained.

The calling line class of service and equipment location is stored in the originating register (on relays on the originating register line memory frame) by the marker for subsequent use on marker intraoffice or outgoing trunk jobs.

4.10 The equipment location of the calling line is identified in terms of the line link frame number, the vertical group, the horizontal group, and the vertical file numbers.

4.11 A vertical group of subscriber lines is five verticals wide on either ten switches high on the straight line link frame, or on the split frame arrangement, it is five switches high on the left and five high on the right. The number of vertical groups of a line link frame will vary from four in a 190-line frame to twelve for a 590-line frame. A horizontal group is one switch high and extends across the vertical groups of a frame. There are always ten horizontal groups on a frame. A vertical file is one vertical wide and ten switches high for a total of ten lines. The number of vertical files on a frame depends on the number of lines on that frame. The division of the frame into vertical groups, horizontal groups, and vertical files is illustrated in Fig. 38, attached.

4.12 The number of the line link frame, of the vertical group, and of the horizontal group in which the line appears is transmitted to the marker via the line link marker connector. Therefore, at this point, the calling line location is determined to within five lines. The other piece of information required by the marker to completely identify the line location within the frame is the vertical file number. This is obtained from the line link frame through the line link connector which is another connector directly associated with the frame.

4.13 While the marker is recording the above information (except for the vertical file number), it is also selecting an originating register. Originating registers are distributed as equally as possible over all the trunk link frames. An idle register is selected in the same manner as an idle trunk. The marker is notified by means of test leads from each trunk link frame which frames have at least one idle register and are not being held busy by other markers. It selects, in a preference sequence, an idle frame having one or more idle registers and connects to that frame through a trunk link connector. (See Fig. 37, attached, connection 2.) The marker then selects an idle register on that frame in a preference sequence.

4.14 After the marker selects a trunk link frame, it goes back to the line link frame via the line link connector. Each line link frame has a line link connector which carries the leads for vertical file identification (previously mentioned) and other leads, which the line link marker connector does not have, for completing connections to the frame (connection 3). The vertical file number is transmitted to the marker which now has all the data for locating the position of the line on the line link frame, namely: the vertical group, horizontal group, and vertical file numbers.

4.15 Identification of the class of service of the calling line is passed to the marker from the line link frame via the line link connector after the vertical file number has been recorded. Class-of-service identification is through a vertical file, and there is a maximum of sixty classes of service per marker group. The assignment of a vertical file to a class of service is on a cross-connection basis. Therefore, any class of service can be assigned to any vertical file. The marker transmits the equipment location and class of service of the calling line to the originating register where this information is stored.

4.16 The marker now must select an idle channel between the subscriber line and the originating register. A channel consists of a line link, a junctor, and a trunk link. Channels are arranged in groups of ten so that the marker can check ten channels at one time. If the number of channels in an office is not divisible by ten, one group will have nine or fewer channels in it. When the marker finds an idle channel, it operates the select and hold magnets required to close through the channel. The marker then indicates to the originating register the identity of the line link used in the channel, and the register stores this information for later use.

4.17 Before the marker transfers control of the channel to the originating register, it checks the connection for continuity (connection 4). The marker then releases its associated connectors and itself and leaves in the register the calling line equipment location in terms of the line link frame number, vertical group number, horizontal group number, and vertical file

number, and also registers the number of the line link used in the dialing connection and the class of service of the calling line. The register now furnishes dial tone to the subscriber and is ready to receive the digits which are dialed. As soon as its function is completed, each item of equipment is released.

4.18 The digits which the subscriber dials are registered in the originating register. As soon as dialing is completed, the originating register seizes a marker and transmits the registration to it.

4.19 It normally takes less than half a second to establish the dialing connection and return dial tone to the calling subscriber.

Pretranslation

4.20 Pretranslation is the process of determining from the first one, two, or three dialed digits how many more digits the register should expect to receive on the particular call. It is called pretranslation because it takes place before marker translation and is required when the total number of digits in the office codes within the range of customer dialing varies and when some called numbers have party letters.

4.21 Where the volume of calls of this nature is not great and the numbering plan is not too complex, pretranslation can take place in the originating register. The register can be arranged to determine how many digits it should receive from the first digit or from a limited combination of the first and second digits.

4.22 For more complex numbering plans, a separate pretranslator circuit is provided. This circuit is called in by the pretranslator connector when the first two or three digits have been set in the originating register. The pretranslator determines from these digits how many more should be dialed and tells the register that it must wait for these before it calls in a marker.

4.23 On calls to stations where a party letter is part of the directory number, the register has to wait for an extra digit. This situation is known as stations delay. The pretranslator recognizes stations delay from the dialed code and informs the register to wait for a possible additional digit.

4.24 A uniform numbering plan without party letters or ringing digits eliminates the necessity for pretranslation.

Intraoffice Calls

General

4.25 When the calling subscriber removes the receiver from the switchhook, the dialing connection is established as described above. After the number is dialed, the originating register engages a marker through an originating register marker connector. (See Fig. 39, attached, connection 1.) The register then transmits the line equipment location of the calling line and the digits of the called number to the marker. The marker translates the office code and determines that the called number is assigned to the same marker group as the calling line.

4.26 The marker then proceeds to perform an intraoffice trunk job which consists of two parts, the establishment of a terminating and an originating connection. The terminating connection is set up between the called line and the B appearance of the intraoffice trunk; the originating connection is set up between the calling line and the A appearance of the trunk.

Establishing Terminating Connection

4.27 The terminating connection is established first so that if the called line is busy, the marker can immediately connect the calling line to a tone trunk and thus save holding time on equipment. Before the terminating connection can be set up, the marker has to obtain the following information from the number group:

- (a) The equipment location of the called number.
- (b) The setting of the ringing selection switch.
- (c) Whether terminal hunting is necessary.

Nonterminal Hunting

4.28 The marker gains access to the number group through the number group connector. (See Fig. 39, attached, connection 3.) The proper number group frame is selected from the dialed thousands digit and the hundreds, tens, and units digits of the called number are transmitted to it. The number group frame translates these digits into an equipment location in terms of line link frame vertical group, horizontal group, and vertical file numbers and transmits this information to the marker. The number group also informs the marker as to the correct setting of the ringing selection switch for ringing the called number. The ringing codes appear on the horizontals of the ringing selection switch while the trunks appear on the verticals and the marker operates the select and hold magnets in order to connect individual or proper party-line ringing to the trunk.

4.29 While the marker is obtaining this information from the number group, it is also selecting an intraoffice trunk on an idle trunk link frame (connection 2). Through the line link connector, the marker gains access to the line link frame on which the called subscriber line is located (connection 4). If it is not busy, the terminating connection is set up between the B appearance of the intraoffice trunk on the trunk link frame and the called line (connection 5).

4.30 If there is no idle channel available, the marker recycles by releasing the intraoffice trunk it was holding and selecting another one (usually on another frame). If there is no idle channel on this recycle, the marker reroutes the call to a tone trunk.

Terminal Hunting

4.31 A subscriber who has more than one terminating line is assigned one directory number per line with usually only the lowest number listed in the directory. These lines, which form a terminal hunting group, are usually consecutively numbered. If the listed number is called and is busy, the marker tests the next higher number in the group and completes the call to the lowest idle number. The marker hunts in the same manner if one of the intermediate numbers is called and is busy.

4.32 Each number group is divided into ten hundreds blocks, each containing ten blocks of ten numbers. One hunting group can spread over more than one hundreds block or more than one tens block. Two or more hunting groups other than blank number or intercept trunks may appear in any tens block. Nonhunting terminals may appear in the same tens block with hunting groups except as noted below. Where there are more than ten trunks but less than one hundred, the "block select" method can be used. By this method, the marker hunts first through the lines located in the directory number tens block, and finding them all busy, will select the lowest block containing at least one idle line without testing the intermediate blocks containing all busy lines. The allotted PBX hunting group feature can also be used. With this feature, the line numbers of a hunting group may be assigned in more than one number group (eight number groups maximum). The marker recognizes the thousands, hundreds, and tens digit before connecting to any number group and steers the call to a tens block on a preferred number group containing idle lines to the PBX. Because the marker does not look at the units digit initially, the tens block containing the listed directory number must not contain numbers of any other subscriber. The latter two plans require an auxiliary relay per PBX trunk.

Establishing Originating Connection

4.33 After the terminating connection is established, the marker proceeds to set up an originating connection between the calling line link frame and the A appearance of the intraoffice trunk on the trunk link frame over an idle channel (connection 7). The marker seizes the line link frame of the calling subscriber, as shown in connection 6. Before it releases the dialing connection, the marker determines whether there is an idle channel between the calling subscriber and the A appearance of the intraoffice trunk. If there is an idle channel, the dialing connection is released immediately, enabling the marker to use the dialing connection line link as part of the originating connection, if necessary. However, if there is no idle channel available, the marker recycles as described above. If no idle channel is found on the recycle, overflow tone is returned from the originating register through the dialing connection.

4.34 After the marker sets up the ringing selection switch in the terminating connection in accordance with the information obtained from the number group, it releases itself and the originating register from the intraoffice connection. The dialing connection is disengaged and the subscribers are interconnected. The trunk now controls the ringing and supervision of the call. The ringing is tripped when the called party answers and the ringing selection switch releases. When the call is finished, the originating and terminating connections are broken and the intraoffice trunk is released.

Timed-release Feature

4.35 A timed-release feature is provided in order to prevent the calling party from holding the called line out of service indefinitely by failing to hang up the receiver. In this case, the timed-release feature automatically disconnects the calling line 13 to 35 seconds after the called subscriber hangs up. If the calling subscriber disconnects first and the called subscriber fails to disconnect, the timed-release feature disconnects the called party after 13 to 35 seconds.

Interoffice Calls - Outgoing

General

4.36 Outgoing calls are established to subscribers in a connecting office or to operators (toll, assistance, and service code calls; Fig. 43, attached). Calls to connecting offices require the services of an outgoing sender; assistance and service code calls usually do not.

Establishing Outgoing Trunk Connection

4.37 When the subscriber has dialed the called number, the originating register engages a marker via an originating register marker connector. (See Fig. 40, attached, connection 1.) The register transmits the following information to the marker: the equipment location and class of service of the calling subscriber, the number of the line link frame used in the dialing connection, and the called number.

4.38 From the office code, the marker learns:

- (a) That the call is to be completed to a connecting office and requires a marker outgoing trunk job.
- (b) What type of pulsing that office requires (multifrequency, dial, revertive, or panel call indicator pulsing).

By means of the outgoing sender connector, the marker gains access to an outgoing sender that sends the type of pulses which the connecting office receives (connection 2).

4.39 When the outgoing sender connector is engaged, the marker, by means of the trunk link connector, gains access to an idle trunk link frame and an outgoing trunk on that frame (connection 3). The sender is now connected to the marker through the outgoing sender connector, and receives the called number from the marker. The marker also sets up a connection between the outgoing trunk and the outgoing sender through the sender link.

4.40 As soon as the trunk link frame is seized, the marker connects to the line link frame of the calling subscriber (connection 4) and establishes a channel between the subscriber and the outgoing trunk (connection 5). The dialing connection is released if the marker finds an idle channel and the line link used in the dialing connection may be reused in the outgoing connection in the same manner as for the intraoffice call. If there is no idle channel available, the marker recycles the call by releasing the outgoing trunk it was holding and selecting another one. If there is no idle channel on this recycle, the marker reroutes the call to a tone trunk on a trunk link frame.

4.41 The outgoing sender then makes trunk test. If trunk test fails, overflow tone is returned to the subscriber from the trunk. As in an intraoffice call, the marker releases upon completion of its functions. The sender transmits the called number to the connecting office and then disconnects itself and the sender link. The outgoing trunk maintains supervision of the call.

(a) The DP outgoing sender is arranged (optionally) to prefix up to three arbitrary digits when the call is routed through a distant tandem point which consumes the prefixed digits in completing the connection to the office of destination. The sender is also arranged to delete some of the digits originally dialed by the customer.

Interoffice Calls - Incoming

General

4.42 An incoming call is the continuation and completion in a called office of an outgoing call from a connecting office. In the called office, the trunk from the originating office is termed an incoming trunk. The incoming connection consists of a channel between an incoming trunk and the called subscriber.

Establishing Incoming Trunk Connection

4.43 As soon as the incoming trunk is activated by a call originating in a connecting office, it seizes an incoming register through an incoming register link. (See Fig. 41, attached, connection 1.) Separate groups of incoming registers are provided for each type of pulsing that the office is equipped to receive (multifrequency, dial, or reverive pulsing).

4.44 After the idle trunk is seized in the called office, the incoming register is connected to the incoming trunk and then receives the numerals of the called number. (In this example, it is assumed that the trunk is used for completing calls to only one of several offices which may be served by a marker group.) The register records the number of the trunk link frame on which the incoming trunk appears in order that the marker will later be able to reach that incoming trunk. After the numerals of the called number have been registered, the register gains access to a marker through an incoming register marker connector (connection 2) and transmits the called digits and the trunk link frame number to it.

4.45 The marker first seizes the trunk link frame (connection 3) and then selects the proper number group frame from the called thousands digit (connection 4). The number group translates the called hundreds, tens, and units digits. As soon as the marker determines the called line location from the number group, it seizes the proper line link frame and performs the line-busy test on the called line (connection 5).

4.46 If the called line is idle, the marker sets up a channel between the trunk and the called line (connection 6). Utilizing the ringing code information it has obtained from the number group, the marker sets the ringing selection switch. If the marker cannot find an idle channel, it sets the incoming trunk to reorder signal and releases itself from the connection.

4.47 As soon as the marker has finished the above functions, it disconnects the incoming register, the register link, and itself from the connection. The trunk now controls the ringing and the further supervision of the call. The ringing selection switch vertical releases when the called party answers or the call is abandoned.

4.48 If the called line is busy, the marker sets up a busy signal in the incoming trunk. The marker then releases the incoming register, the register link, and itself from the connection.

Reverting Calls

General

4.49 A reverting call takes place between subscribers who share the same party line. The talking connection is set up between the subscriber line and a reverting trunk when the class of service of the calling subscriber line is flat rate, and when reverting trunks are provided in the office.

4.50 When the class of service of the calling subscriber line is flat rate and reverting trunks are not provided in the office, it is necessary to connect the calling subscriber to an operator over an outgoing trunk to the toll and DSA switchboard. The operator obtains the called subscriber and supervises the connection.

4.51 When the class of service of the calling subscriber is message rate, it is necessary to connect the calling subscriber to an operator regardless of whether or not the office is equipped with reverting trunks. The operator, in addition to obtaining the called subscriber and supervising the call, makes the necessary charge. This operation is employed because the reverting call trunks are not arranged to provide automatic message charging.

Establishing Reverting Trunk Connection

4.52 The calling subscriber receives dial tone and dials in the usual manner. The originating register transmits the calling subscriber line location and class of service, and also the called number to a marker which recognizes that number as belonging to the same office. (See Fig. 42, attached, connection 1.) The marker then proceeds to seize both the proper number group and an intraoffice trunk (connections 3 and 2). Up to the point that the marker checks the number group for the called line location, a reverting call is handled in the same manner as an intraoffice call.

4.53 However, as soon as the marker determines from the number group that the called line location is the same as that of the calling line, it releases the intraoffice trunk. The marker then seizes a trunk link frame on which an idle reverting trunk appears (connection 4) and sets up a channel between the subscriber line and that trunk (connections 5 and 6). After the marker sets up the proper ringing codes in the reverting trunk, it releases itself from the connection. The reverting trunk is now left in control of the call.

4.54 There are two types of reverting trunks:

- (a) Those used for 2-party selective, 4-party semiselective, and 10-party divided code ringing.
- (b) Those used for 2-party selective, 4-party full-selective, and 8-party semiselective ringing.

Depending on its individual needs, an office may have one or both types of these trunks.

2-party Selective Lines (Using Type (a) Trunk)

4.55 In the case of a tip subscriber calling a ring subscriber on a 2-party line, the trunk returns a busy signal to the tip subscriber who hangs up. The trunk then applies regular ringing to the called party and a reverting ringing signal (1/2 second on, 2-1/2 seconds off) to the calling subscriber. When the called subscriber answers, the ringing is tripped; this notifies the calling party to lift the receiver and start talking.

4-party Semiselective and 10-party Divided Ringing Lines (Using Type (a) Trunk)

4.56 The method of operation on these lines is the same as that used on 2-party lines except that the trunk rings all parties on one side of the line. Since each subscriber on the same side of the line has a separate ringing code, only one of the parties will answer.

2-party Selective, 4-party Full-selective, and 8-party Semiselective Lines (Using Type (b) Trunk)

4.57 When a subscriber on a 4-party full-selective or an 8-party semiselective line wishes to call another party on this line, he dials the called number. The originating register engages a marker which connects to a reverting trunk in the same manner as described above and sets the ringing switch for the called station. The trunk then supplies a steady high tone to the calling subscriber; this tone notifies the subscriber to dial an additional digit which is associated with his station for use on reverting calls. From this digit, the trunk selects the individual ringing position for the calling station. After the extra digit is dialed, the trunk supplies busy signal to the calling station. The calling subscriber hangs up and the trunk proceeds to ring the called and calling stations alternately.

4.58 When the called station answers, the ringing is tripped. This notifies the calling subscriber to remove the receiver and start talking. When both subscribers hang up, the equipment returns to normal.

Assistance and Service Code Calls

General

4.59 Calls for which a subscriber dials zero or a service code are completed over channels between the calling subscriber and an appropriate outgoing trunk. (See Fig. 43, attached.) When there are direct trunks to the operator positions, no outpulsing is necessary, and therefore, outgoing senders are not required in the connection. However, service code calls may sometimes be handled through a centralized point, and in that case, an outgoing sender is required to outpulse the dialed digits.

4.60 Pretranslation is not necessary because the originating register is equipped to recognize the zero and service codes directly.

Assistance Calls

4.61 When making operator calls, the subscriber dials zero. The originating register records this single digit, and without waiting for any more, engages a marker (connection 1). The marker establishes a channel between the

calling line and an outgoing trunk to an operator and releases itself (connections 2, 3, and 4). The subscriber hears an audible ringing signal until the operator answers. After the operator has connected to the trunk, the circuit is so arranged that even if the subscriber hangs up, the operator can still hold the connection. This prevents any accidental manipulation of the switchhook from destroying the connection.

Service Code Calls

4.62 Calls to a service code operator (business office, long distance, repair service, etc.) follow a similar pattern. When the originating register receives the service code digits, it engages a marker and transmits them to it. The marker then sets up a channel between the calling subscriber and an outgoing trunk to the proper operator or desk and then it releases. The subscriber hears an audible ringing signal until the operator answers. When the subscriber hangs up, the connection is released.

Manual Calls

4.63 A dial office may also serve some manual subscribers who require the assistance of an operator on all originating calls.

4.64 When a manual subscriber lifts the receiver from the switchhook, the line link marker connector engages a marker. At the same time that it is receiving the line link frame location and the class of service of the calling line from the connector, the marker selects an idle originating register as though the call were from a dial station. The marker transmits the above information to the register and releases. No dial tone is returned to the subscriber because the register recognizes the class of service of the calling line as manual. The originating register then seizes a marker and indicates that a connection to an operator is required. The marker establishes a channel between the calling manual subscriber and an outgoing trunk to a DSA operator. The operator then completes the call at the request of the subscriber.

Dialing Into an Adjacent Area

4.65 One of the features of the No. 5 crossbar system is a means whereby subscribers served by an office in one numbering area can dial directly into an adjacent numbering area even when the same office codes are used in both areas. Where such an arrangement is provided, a directing code which identifies the called area must be dialed before the called directory number. The primary purpose of this directing code is to avoid any confusion from any conflicting codes in the two areas. The marker in the calling office is arranged to recognize the directing code and to set up a connection to an outgoing trunk that goes directly to the called adjacent area.

4.66 The No. 5 crossbar system is so designed that customers may dial into all the numbering areas now in use in the United States and Canada. The calling customer dials first the 3-digit national area code of the numbering area of the called customer then the 7-digit directory number of the called customer. The marker in translating the area code, establishes the connection to a trunk directly to a switching center in the area dialed

or to an intermediate toll switching point which will select a route to the area dialed. Where more than one route is available from the No. 5 crossbar office to a particular area, the marker determines from its foreign area translator which route to use to the particular office. It is likely that customer dialing access will be limited to 2-letter, 5-digit numbering plan areas.

Various Call Conditions

Permanent Signal

- 4.67 A permanent signal may result from faulty handling of the station equipment or from trouble conditions in the telephone plant.
- 4.68 After dial tone has been sent to the calling line, the originating register waits for dialing to start.
- 4.69 The register allows 20 to 35 seconds, under normal traffic conditions, for the receipt of the first digit. If it does not receive the first digit in that time, the register refers the call to a marker as a permanent signal. The marker then connects the calling line to a permanent signal trunk. Before releasing, the marker indicates to the trunk whether the calling line is coin, PBX, or a noncoin, non-PBX class.
- 4.70 The signal first appears before an operator. The operator challenges on the trunk, and if she receives no answer, takes the necessary action as covered by local instructions.

Partial Dial

- 4.71 After the dialing connection has been established and dial tone is transmitted to the subscriber, the originating register waits for the dialed digits. The register waits 20 to 35 seconds, under normal traffic conditions, for the first digit and the same length of time for each succeeding digit.
- 4.72 If the subscriber fails to dial a digit within this specified time interval, the register refers the call to a marker as a partial dial. The marker may handle the situation in one of two ways:

- (a) It may connect the calling line to a tone trunk.
- (b) It may connect the calling line to an outgoing trunk which terminates before an operator.

The method that is used depends on the procedure followed in the individual office.

Dialing Before Receipt of Dial Tone

- 4.73 If a subscriber starts dialing before receiving dial tone, one of the following situations will occur:
 - (a) The first digit may be distorted so that the originating register will record an incorrect code.
 - (b) The register will record an insufficient number of digits.

4.74 In the first case, if the code which the register records is a working one, the calling subscriber may get a wrong number. However, if the digits recorded by the originating register constitute a vacant code (a code not in current use), the calling party will be connected either to an operator or to a tone trunk.

4.75 If pretranslation is provided in the originating register, the register recognizes the vacant code and engages a marker as soon as the first three digits have been dialed. The marker receives the vacant code digits from the register and routes the call to an operator or a tone trunk.

4.76 If pretranslation is not provided, the originating register does not recognize the vacant code; therefore, it waits for the full directory number before it engages a marker. The marker then recognizes the vacant code and routes the call as described above.

4.77 In the second instance, where an insufficient number of digits are recorded, the call is treated as a partial dial.

Intercepting

4.78 A call is intercepted if it is made to any of the following:

- (a) A subscriber whose telephone has been temporarily disconnected or whose number has been changed.
- (b) A subscriber whose telephone is out of order and arrangements have been made to intercept incoming calls.
- (c) A subscriber whose telephone has been permanently disconnected.
- (d) An unassigned number.
- (e) A blank number.
- (f) Vacant code (when handled by operator).

4.79 When a number, which is on intercept for reasons (a) or (b) above, is called, the calling party is routed to an intercept operator over an intercept trunk. Each intercept trunk has a line link appearance and is assigned a number in a number group; these numbers are in a terminal hunting group. Therefore, on an intraoffice or incoming call, when the marker seizes the number group and finds that the called number is on intercept, it goes to an intercept trunk group (which may be on the same or a different frame) and obtains the equipment location of an intercept trunk. Through a line link connector, the marker seizes the line link frame on which the trunk appears and establishes a channel between the calling line and the intercept trunk. The other appearance of this trunk is before an intercept operator.

4.80 Blank numbers, permanent disconnects, and unassigned numbers are also treated in this manner, except that a recorded announcement may be connected to the other end of the trunk. Unassigned numbers are numbers in an office which are not currently assigned to subscribers; blank numbers are numbers which do not exist in the office at all.

4.81 For example, in an office which is equipped to serve 5000 directory numbers, there are always some numbers within the 5000 which are not allotted to subscribers. When such numbers are dialed, the marker, after learning from the number group that the number is on intercept, connects the calling subscriber to an intercept operator or a recorded announcement.

4.82 If, using the same office as an example, a subscriber dials a number above 5000, this is called a blank thousands number. When such a number is dialed, the marker recognizes it immediately and connects the calling subscriber to an intercept operator or a recorded announcement.

C. Message Charging on Coin and Noncoin Calls

Prepayment Coin Service

4.83 There are two types of prepayment coin service: coin first (the most common) and dial tone first. With coin first service, a coin must be deposited before dial tone is returned to the calling party. Conversely, with dial tone first service, dial tone is returned when the receiver is removed from the switchhook; a check for coin deposit is made after dialing is completed. Only coin first, ground start service is discussed here, which is required for 10-cent coin operation.

4.84 With ground start operation, the customer is connected to an originating register after a coin is deposited. When dialing is completed, the originating register engages a marker and transmits the usual information to it, including the coin class of service of the calling party. The marker then establishes a connection between the calling party and a trunk arranged for coin operation.

4.85 The answer of the called subscriber sets the charge condition in the trunk. If the office has no provision for overtime charging, the collection of the coin is made when the calling subscriber disconnects at the end of the call. For example, when the called subscriber takes the receiver off the hook, the battery and ground on the trunk pair is reversed. When the receiver-off-the-hook situation persists for the charge delay interval of 2 to 5 seconds, the charge condition, which determines that the calling party will be charged for the call, is set in the trunk.

4.86 Busy and overflow signals are also returned by reversing the battery and ground, but this is a flashing reversal under the control of an interrupter which usually supplies interruptions at 60 ipm for busy signal and 120 ipm for overflow. Therefore, the reason the final charge condition is not set in the trunk until the 2- to 5-second interval of uninterrupted battery and ground reversal has elapsed is to prevent false charging on busy and overflow reversals.

4.87 On an intraoffice call, the 2- to 5-second charge delay interval is the same but the charge condition is locally set in the trunk.

4.88 When the calling party disconnects, the trunk used in the talking channel associates itself with a coin supervisory circuit through a coin supervisory link. (See Fig. 44.) The coin supervisory circuit then tests for and collects the coin if the charge condition has been set; if it has not, the coin is returned.

4.89 After coin collect or return is made, the coin supervisory circuit again tests for the presence of the coin ground. If the coin ground is found to be still in the box, the circuit signals a stuck-coin condition to an operator. From the signal, the operator knows whether the coin should be collected or returned and tries to dispose of the coin. If this is unsuccessful, the line is considered out of order because of the stuck-coin condition and is referred to the maintenance department.

4.90 When the circuits are arranged for coin overtime, an additional charge is made for each 5-minute interval of conversation beyond the initial 5-minute period. The trunks are equipped with interval timers and cause the coin to be collected 4-1/2 minutes after the charge condition has been set. At this time, a tone is put on the connection for one-half second to remind the calling party that another coin must be deposited if the conversation is to continue beyond the next half minute without interruption. At the end of 5 minutes, if the connection has not been released, the coin supervisory circuit is again connected to the trunk to test whether a coin has been deposited for overtime. If it has been deposited, the coin control circuit releases itself and allows the conversation to continue without interruption; if not, an operator is signaled in on the connection and she requests an additional coin. The coins for overtime service are collected at the 4-1/2-minute point of each 5-minute interval. These intervals are shown in Fig. 45. If another coin is deposited after the 4-1/2-minute signal but the connection is released before the full 5 minutes have passed, this coin is returned by the coin supervisory circuit.

4.91 On 0 and 211 calls, the initial deposit is returned by the trunk when the operator answers or if the customer hangs up before the operator answers. If it is desired, 0 trunks may be adjusted to retain the coin on operator answer.

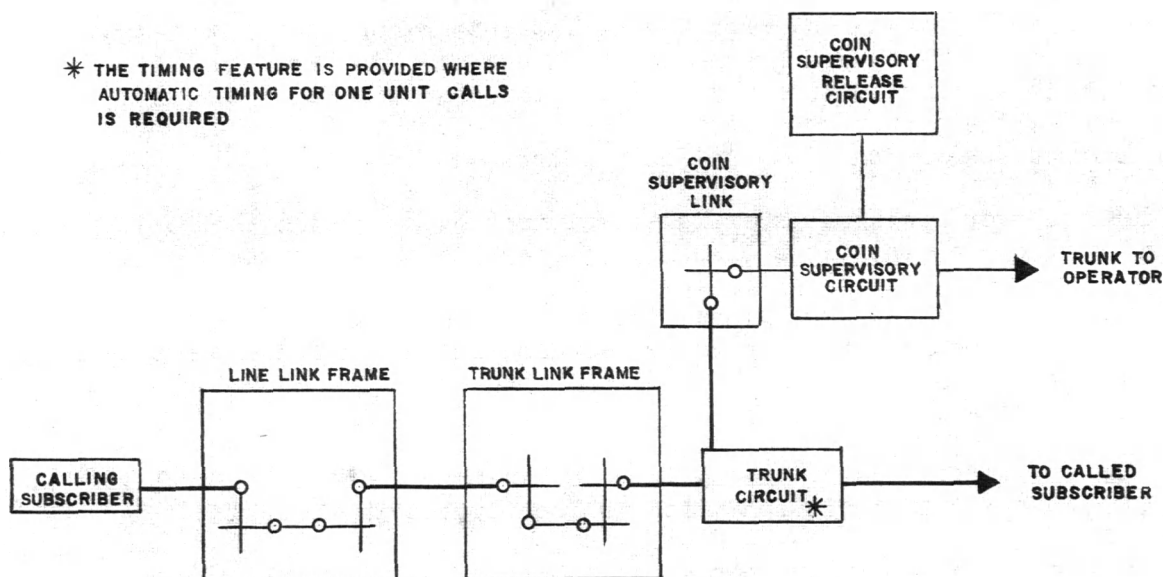


FIG. 44—ASSOCIATION OF COIN TRUNK AND COIN SUPERVISORY LINK

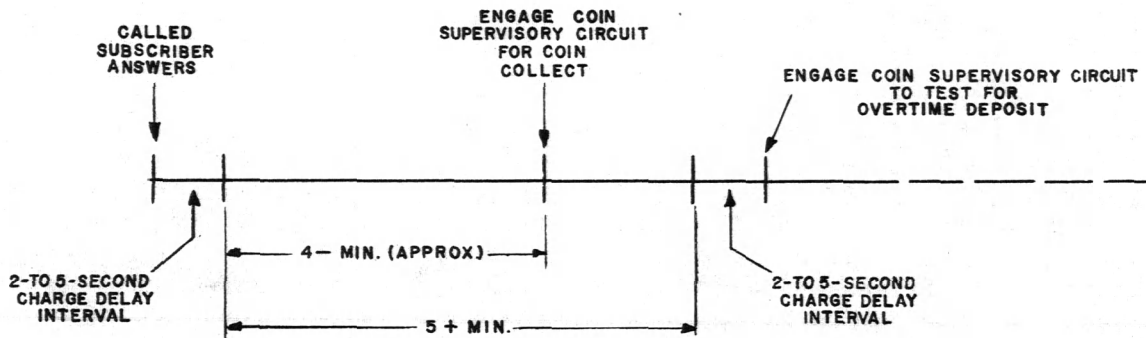


Fig. 45 - Intervals for Coin Operation With Overtime

- 4.92 On service codes and all other calls except as mentioned, the trunks call in coin supervisory circuits to dispose of the coins.

Trunking for Coin Calls

- 4.93 Separate groups of trunks are provided on an alternate route basis for handling outgoing interoffice calls dialed from coin lines. The types of trunks and the method of operation are discussed in M, Coin Junctor Operation.

Message Register Service

General

- 4.94 Message register charging, as an alternate method for recording calls to one message unit areas, is handled by means of an individual message register located in the central office and directly associated with a subscriber line. Message registers can be assigned only to individual and 2-party lines and are operated on calls for which the subscriber is charged. With this type of service, the subscriber charges are based on the number of operations of the message register. Provision can be made for overtime charging according to the needs of each office.

- 4.95 Message registers are operated on calls to one message unit areas only. Calls beyond the one message unit area must be handled through an operator or AMA equipment.

- 4.96 Flat rate subscribers do not have message registers attached to their lines because they are allowed an unlimited number of calls in their flat rate calling area and all calls involving message charging are handled by an operator or AMA equipment.

Message Rate - Individual

- 4.97 Originating register operation is the same for individual message rate and flat rate subscribers. When a message rate subscriber finishes dialing, the originating register engages a marker and transmits the class of service of the calling line to it. If the call is not for a free code, the marker seizes a trunk link frame that has trunks arranged for message rate operation.

4.98 When the called subscriber answers and the supervision on the trunk has been reversed for 2 to 5 seconds, the charge condition is set in the trunk. The message register is then operated by the trunk, which controls the supervision of the call, and the call is completed in the usual manner. An office may provide for overtime charging on nonzone calls or this feature may be omitted. In offices which do charge for overtime, a message charge is made for each 5-minute period by operating the message register once at the start of conversation and again at the beginning of each 5-minute period. Five-minute timing switches are provided in trunks equipped for message register operation in order to control overtime charging.

Message Rate - Two Party

4.99 Each 2-party line is arranged for the attachment of both a tip and a ring message register. One register records the calls made by the ring party and the other those made by the tip party.

4.100 When the marker receives a 2-party class-of-service indication, it passes the information on to the originating register. The register then makes party identification test to determine whether the tip or the ring subscriber is making the call. The tip party is identified by a 1000-ohm ground on the line; the ring station is identified by the absence of such a ground. To protect against false 2-party identification due to manipulation of the switchhook, the originating register makes the party-line identification test twice, once before dial tone is transmitted and again before the register engages a marker to complete the call.

4.101 The talking connection is established to a trunk arranged for 2-party message rate operation. The marker then sets the charge condition for either the tip or the ring party in the trunk. After the called subscriber answers and the charge delay interval elapses, the message register is operated. As on individual lines, provision can be made for overtime charging. The call is completed in the same manner as a flat rate call.

AMA Service

General

4.102 AMA equipment is also used to record elements of charging information on calls involving one or more message unit charges or toll charges. The detailed description of the AMA system is given in the reference designated in 1.02. Outgoing trunks that carry charged calls are associated with an AMA recorder and perforator in groups of 100 or less trunks per recorder. When a noncoin customer dials an office code or national area code that involves a message or toll charge, he is connected to a trunk which can connect him to the distant point. At the same time the following details of the call are recorded on the punched tape:

- (a) Trunk number
- (b) Calling number
- (c) Called number

- (d) National area code
 - (e) Message billing index
 - (f) Other miscellaneous detail
- 4.103 The recorder is then released for use by other trunks.
- 4.104 If the call is to be bulk billed, the called number, national area code, and some details are omitted.
- 4.105 When the called party answers and the conversation terminates, separate entries are made on the tape, each consisting of the trunk number, the time, and an entry index.
- 4.106 These tapes are processed through the accounting center at periodic intervals. From the basic data on the tape, the subscribers calls are tabulated and arranged in numerical order of telephone numbers.

D. Operation of No. 5 Crossbar Office With Combined Toll and DSA Switchboard

General

- 4.107 In this discussion, the switchboard is considered as being a combined toll and DSA switchboard, and also as being in the same building with the No. 5 crossbar office. In the sections that follow, the terms "combined toll and DSA switchboard" and "switchboard," and also the terms "combined toll and DSA operator" and "operator" are synonymous.
- 4.108 The only difference between having the switchboard in the same building or in another building is in the type of trunks used. Otherwise, the method of operation is the same for both conditions.
- 4.109 The types of calls which may be handled by switchboard operators are shown by Fig. 46. Some service code calls are answered by the information operator, repair clerk, etc., instead of by the toll and DSA operator. Permanent signal, partial dial, and vacant code calls appear at the switchboard or are routed to tone trunks, according to the practice in individual offices.
- 4.110 Each incoming trunk to the switchboard has a lamp appearance before an operator which signals her to answer the call and take the appropriate action. This operator has access to various types of outgoing trunks over which calls are extended from the switchboard.
- 4.111 If the traffic warrants it, there are straightforward trunks to manual offices from the switchboard. There is no pulsing over these trunks. When an operator plugs into such a trunk, an idle operator at the other end is signaled and she connects to the trunk. This causes a zip tone to be sent to the originating operator, signaling her to pass the called number.
- 4.112 Wherever the traffic is heavy enough, direct or tandem trunks are provided between the switchboard and certain connecting offices. The operator can key or dial the called number directly into these outgoing trunks and reach the connecting office without going through the No. 5 crossbar office.

INCOMING TRAFFIC TO
TOLL AND DSA SWITCHBOARD
ASSOCIATED WITH
NO. 5 CROSSBAR OFFICE

OUTGOING TRAFFIC FROM
TOLL AND DSA SWITCHBOARD
ASSOCIATED WITH
NO. 5 CROSSBAR OFFICE

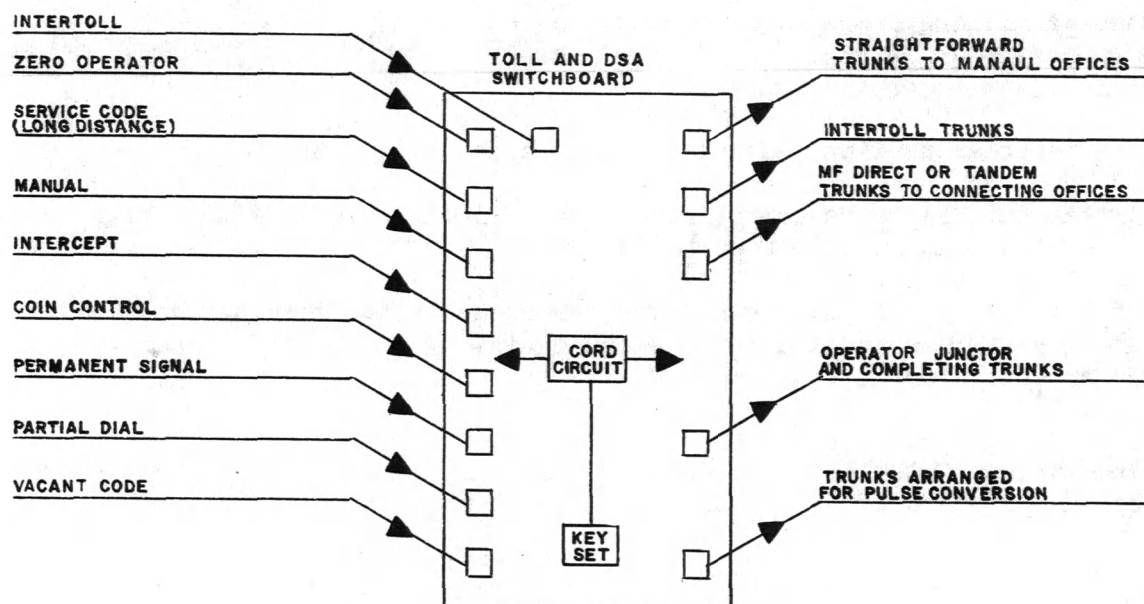


Fig. 46 - Traffic at a Combined Toll and DSA Switchboard Associated With a No. 5 Crossbar Office

4.113 There are also operator junctors and trunks arranged for pulse conversion outgoing from the switchboard. The operator can handle operator assistance completing traffic by means of these trunks.

Assistance and Long Distance Calls

4.114 A dial subscriber who desires the service of an operator in order to make a long distance call or to complete a local call dials the long distance code or 0 and is routed to a combined toll and DSA operator. A manual subscriber need only lift the receiver from the switchboard to be connected to an operator. Some of the duties of an operator are:

- (a) To complete calls for subscribers who require assistance.
- (b) To check complaints about called numbers which are continuously busy or unanswered.
- (c) To complete calls to numbers beyond the subscriber's dialing area.
- (d) To complete calls to manual offices within the local service area where these offices are not arranged for call indicator operation.

Call From Switchboard Completed to No. 5 Crossbar Subscriber

4.115 The operator can complete calls to subscribers in the No. 5 crossbar office over toll switching trunks. These trunks have two locations: one at the switchboard and the other on a trunk link frame. (See Fig. 47, attached.)

4.116 The operator plugs into a toll switching trunk (connection 1). The trunk is connected to an incoming register through an incoming register link (connection 2). The operator keys the four numerals. (A directing digit is prefixed if the trunk serves more than one office code.) The call then proceeds like a regular incoming call (connections 3, 4, 5, 6, and 7).

Call From Switchboard to a Connecting Office

4.117 By means of a trunking arrangement called an operator junctor, an operator located in the same building as the No. 5 office can gain access to the outgoing trunks in that office. This operator junctor operation is discussed in L of Part 4.

Pulse Conversion Outgoing Calls

4.118 A combined DSA and toll switchboard, located in the same building as the No. 5 crossbar office which it serves, may have, if the traffic warrants it, direct trunks to a connecting office which receives only dial or revertive pulsing. These trunks are provided for calls that require the assistance of an operator. By means of a process known as pulse conversion, the operator can complete a call from the No. 5 crossbar office to such a connecting office.

4.119 Pulse conversion is the action of converting MF pulsing received from a switchboard position to the type of pulsing required by the office to which the call is completed. This type of pulse conversion requires that these pulses be converted to either dial or revertive pulses, whichever are required by the connecting office. This method of completing calls to a connecting office from a DSA switchboard is economical and efficient for three reasons:

- (a) No junctors are used in the connection.
- (b) The operator just keys the numerals of the called number into the trunk when completing to a local office. (Directing digits are prefixed if the trunk serves more than one office code.)
- (c) The switchboard sender for converting pulses to the proper type is eliminated.

4.120 A pulse conversion trunk first operates as an incoming trunk by seizing a MF incoming register and passing pulses to it. Later, it acts as an outgoing trunk by connecting to a dial or reverting pulse outgoing sender and transmitting the required type of pulses to the called office.

4.121 The calling subscriber reaches the DSA operator in the usual manner and tells her the called number. From this information, the operator plugs into a trunk arranged for pulse conversion outgoing to the called office. (See Fig. 48, attached, connection 1.) Through an incoming register link, the trunk is connected to a MF incoming register (connection 2) and transmits the trunk class mark indication to it. The operator then keys the number after receiving a start dialing signal.

4.122 The incoming register seizes a marker through an incoming register marker connector (connection 3) and transmits the above information to it. From the trunk class mark, the marker learns that this is a pulse conversion job and determines whether a dial or revertive pulse outgoing sender is required. It then seizes the proper sender through an outgoing sender connector and transmits the called numerals to it (connection 4). The outgoing sender is connected to the trunk through a sender link (connection 5), and after making trunk test, outpulses the digits to the connecting office. The talking connection is established over the trunk (connection 6). The crossbar control equipment is released and the operator supervises the call.

E. Operation of No. 5 Crossbar Office With DSB Switchboard

General

4.123 A No. 5 crossbar office which receives calls from manual switchboards not equipped with keysets or dials must have a DSB switchboard associated with it. The operating method in such a case is known as straightforward trunking. An incoming trunk from such a manual office is connected to a central B incoming register in the No. 5 crossbar office through an incoming register link. The central B incoming register is permanently connected to a B switchboard sender which is located at the central DSB switchboard office.

Operation With DSB Switchboard

4.124 When a subscriber, who is served by a manual office not equipped with keysets or dials, originates a call to a subscriber served by a No. 5 crossbar office, the called subscriber directory number is given to the operator in the usual manner. The manual operator plugs into an outgoing straightforward trunk which terminates in the called No. 5 crossbar office. (See Fig. 49, attached, connection 1.) This trunk is connected via an incoming register link to a central B incoming register (connection 2) which immediately, without waiting to receive any pulses, signals its associated central B switchboard sender to obtain an idle B position (connections 3 and 4). As soon as an idle B position is selected, order tone is sent to the originating and B operators. This tone warns the B operator to expect the called number and signals the originating operator to transmit it. The called number is transmitted verbally to the B operator who keys it in the sender (connection 5).

4.125 If there is only one office code used by the called No. 5 crossbar office, a double order tone is given to the originating and B operators, indicating that the originating operator should pass only the numerals of the called number and that the B operator should receive and key just the numerals into the central B switchboard sender. If the called No. 5 crossbar office uses more than one office code, a single order tone is sent to the originating and B operators, indicating that both the office code and the numerals of the called number should be passed by the originating operator, and that the B operator should receive and key both the office code and the numerals into the central B switchboard sender.

4.126 After the number is keyed, the sender transmits it to the register and releases itself from the connection (connection 6). The central B incoming register then connects to a marker and transfers to it the information concerning the called number, the trunk link frame number, and the class mark of the incoming trunk (connection 7).

4.127 The marker proceeds to establish a connection between the incoming trunk and the called subscriber (connections 8, 9, and 10). When the talking connection is established, the marker releases the incoming register and itself; the incoming trunk remains in control of the call (connection 11).

F. No. 5 Crossbar Office With Tandem Switching Features

General

4.128 Since it is not economical to have direct trunks between all central offices, intermediate switching points are provided to handle traffic between offices that have no direct connections. This type of operation is known as tandem switching.

4.129 A No. 5 crossbar office can be used to provide this tandem switching service in addition to its regular functions. An incoming trunk arranged for handling tandem traffic at a No. 5 crossbar office with tandem switching features can also handle traffic for completion to this office since it is generally economical to combine these two types of traffic over the same trunk group. To permit this dual use, it is necessary to provide such trunks with both trunk link and line link frame locations in the No. 5 office with tandem switching features. The trunk link frame location is used when a call coming in on a tandem trunk terminates in the No. 5 crossbar office. When the incoming call is to be switched to a connecting office through the No. 5 crossbar office, the line link frame location is used.

Establishing a Tandem Connection to a Connecting Office Through a No. 5 Crossbar Office

4.130 In Fig. 50, attached, a calling subscriber served by an office, which we shall call X, originates a call to a subscriber served by dial office Z. In this case, there are no direct trunks connecting offices X and Z, and the call is, therefore, routed from office X over a tandem trunk to a No. 5 crossbar office Y, which has completed trunks to office Z. These completing trunks can be used for handling calls from several offices.

4.131 In a No. 5 crossbar office, a tandem trunk incoming from another office is connected to an incoming register through an incoming register link (connection 1). The following information is then transferred to the incoming register: The called directory number; the trunk link frame number (not used on tandem calls); and the trunk number and class mark of the incoming tandem trunk. The trunk number is an arbitrary 3-digit number (000 to 999) assigned to each trunk for the purpose of obtaining the line link equipment location of the trunk. These trunk numbers appear either in a separate trunk number group frame or in a subscriber number group frame. The requirements of each individual office determine which of these two arrangements is used. If there are too many trunk numbers to be handled by the subscriber number group, a separate trunk number group frame is provided. (The called number may consist of five, six, seven, or eight digits: a one-digit office code and four numerals or a one-digit directing code and four numerals; a 2-digit office code and four numerals; a 3-digit office code and four numerals; or a 3-digit office code with four numerals and a party letter.) If the pulses are transmitted on a reveritive pulse basis, the office code is designated by "office brush and

office group" pulses. These pulses are always sent and are translated by the incoming register into a 2- or 3-digit office code as required for presentation to the marker. The register also determines from its translator the number of selections it may expect and whether the code received is a working or vacant code. The offices reached on a revertive tandem basis are limited to forty. This register will handle calls terminating in the local office as well as those terminating in a distant office.

4.132 The incoming register seizes a marker through an incoming register marker connector and transmits the above information to it (connection 2). From the called office code, the marker determines that a tandem job is necessary because the call is to be switched through to a connecting office. It seizes an outgoing sender through an outgoing sender connector (connection 3), proceeds to engage an outgoing trunk on an idle trunk link frame (connection 4), and connects the outgoing sender and the outgoing trunk by means of the sender link. At the same time, from the trunk number, the marker seizes the proper number group frame through a number group connector and obtains the line link frame location of the tandem trunk (connection 5). The marker then seizes the line link frame on which the incoming tandem trunk appears via a line link connector (connection 6).

4.133 A channel is established between the incoming tandem trunk and the outgoing trunk by the marker (connection 7). The marker then releases the incoming register and itself from the connection and the incoming tandem trunk is left in control of the supervision of the call.

4.134 A feature known as tandem screening is available to permit denial of service from specific incoming trunk groups to selected office codes available to other customers. With this feature, customers in noncommon control offices (such as step-by-step) can be given unlimited access to the No. 5 crossbar office; and they can be denied service by the No. 5 crossbar office to those office codes not allowed on a free basis by their tariff. The incoming trunks used for this purpose are given tandem class-of-service treatment.

Establishing a Terminating Connection in a No. 5 Crossbar Office (Via an Incoming Tandem Trunk)

4.135 A call coming over an incoming tandem trunk and terminating in the No. 5 crossbar office is treated in the same manner as a call coming in on a nontandem trunk.

4.136 In Fig. 50, attached, the incoming tandem trunk connects to an incoming register through an incoming register link (connection 1) and transmits the called number and the trunk link frame number to the register. (This called number only ranges from five to seven digits because there are no party letters in a No. 5 crossbar office.)

4.137 The register seizes a marker by means of an incoming register marker connector and transmits the above information to it (connection 2). The marker seizes the trunk link frame (connection 4) and the number group (connection 5). From the number group, the marker gets the line link location of the called number and seizes the proper line link frame (connection 6).

The marker establishes a channel between the incoming tandem trunk and the called line (connection 7). The marker then sets the proper ringing in the ringing selection switch, releases its associated linkage and itself, and leaves the incoming tandem trunk in control of the call.

4.138 A screening feature is also provided on dial pulse incoming nontandem trunks whereby either six or seven digits can be received. This feature is useful when it is not desired to absorb the excess digits in the originating office (such as step-by-step). Under this condition, the marker is handed the incoming class mark, indicating that this particular trunk is incapable of being used in tandem connections, and a signal indicating the proper 6- or 7-digit translator to be used. Then if the marker receives a code not usable over this trunk, it sets up reorder. This feature is applicable regardless of whether or not other trunks in the office or even in the same register link are equipped for tandem operation. The registers must be equipped to record the total number of digits.

G. No. 5 Crossbar Office With Toll Center Switching Features

General

4.139 A local No. 5 crossbar office may be arranged to serve as a toll center for surrounding offices. This type of office handles the following kinds of traffic:

- (a) Its regular local traffic.
- (b) Toll calls which are originated by its own local subscribers or which terminate to its own local subscribers.
- (c) Toll calls which are switched through the No. 5 crossbar office.
(Calls which originate or terminate in near-by tributary or other offices.)
- (d) TX calls to TX operators on the toll switchboard serving the No. 5 crossbar office.

4.140 Traffic between toll offices is carried over intertoll trunks. As mentioned under "Trunks" of Part 3, there are three general types of these trunks; one-way outgoing, one-way incoming, and two way. These trunks have the following frame locations in a No. 5 crossbar office:

- (a) One-way outgoing trunk - only one trunk link frame location.
- (b) One-way incoming trunk - two line link frame locations and one trunk link frame location. The line link frame locations are used on switched through calls. The trunk link frame location is used on incoming calls terminating in the No. 5 office.
- (c) Two-way trunk - two line link frame locations and one trunk link frame location. The line link frame locations are used on switched through calls. The trunk link frame location is used for calls outgoing from the No. 5 office or for incoming calls terminating in the No. 5 office.

4.141 The two line link frame locations for trunks (b) and (c) are provided in order to increase the number of channels between the intertoll trunks and the trunks to connecting offices and thus reduce the number of reorders. In addition to the frame locations listed above, the one-way outgoing and the 2-way intertoll trunks usually have outgoing locations in an intramural toll switchboard.

Establishing A connection for a Toll Call to a Connecting Office Through a No. 5 Crossbar Office

4.142 As shown in Fig. 51, attached, a calling subscriber served by local office X originates a toll call to a subscriber served by office Z. The calling subscriber is connected over a long distance (zero or 211) trunk to an outward toll operator serving office X. The toll operator receives the request of the subscriber and plugs into an intertoll trunk connecting to the No. 5 crossbar office Y which has toll center switching features and is in route to the called office.

4.143 After an intertoll trunk terminating in a No. 5 crossbar office is connected to an incoming register by means of an incoming register link (connection 1), a start pulsing signal is returned to the originating operator. The operator then keys the called number into the incoming register. When the trunk number (000 to 999) and class mark, and the called directory number are transmitted to the incoming register, a marker is seized through the incoming register marker connector and this information is passed to it (connection 2). The marker connects to an outgoing sender via the proper connector and transmits the called directory number to it (connection 3). An idle trunk link frame with a trunk to the connecting office is then seized by the marker (connection 4). (If the called office is outside the toll center area served by the No. 5 crossbar office, an intertoll trunk is used to connect to the toll center in which the called office is located.)

4.144 From the trunk number, the marker connects to one of the proper number group frames, and obtains there the location of one of the two line link locations of the trunk (connection 5). (The trunk numbers appear in two number group frames which may be either in parts of the subscriber number groups or in separate trunk number groups. The requirements of an individual office determine which arrangement is used.)

4.145 The marker then seizes the line link frame on which the incoming intertoll trunk appears and proceeds to set up a channel between this trunk and the outgoing trunk (connections 6 and 7). As soon as its functions are completed, the marker releases. The outgoing sender transmits the called number to the connecting office and releases itself and the sender link, leaving the incoming intertoll trunk in control of the call. The talking connection between the calling and called subscribers is established from office X over an intertoll trunk switched through office Y and an outgoing trunk to office Z.

4.146 If the marker cannot find an idle channel on its first attempt, it releases the line link and trunk link frames and seizes the other number group frame. Here it obtains the other line link location of the intertoll trunk and proceeds to establish a channel as before. If the second attempt is unsuccessful, the marker sets the incoming intertoll trunk to return a reorder signal to the originating operator. The reorder condition is set up through the trunk link frame location of the incoming intertoll trunk.

4.147 Calls to TX operators are established in a similar manner. In Fig. 51, the TX operator is shown as one of the terminating points. The outward toll switchboard operator keys or dials the appropriate TX code. The No. 5 office does not outpulse any digits in this case.

Establishing a Connection for a Toll Call Terminating in a No. 5 Crossbar Office

4.148 In Fig. 51, attached, a calling subscriber served by local office X originates a toll call to a subscriber served by No. 5 crossbar office Y. This call arrives at office Y on an incoming intertoll trunk in the same manner as the above call. This trunk is connected to an incoming register through an incoming register link (connection 1). The called number and the number of the trunk link frame on which the intertoll trunk appears are registered in the incoming register. The register seizes a marker by means of an incoming register marker connector and transmits this information to it (connection 2). The marker seizes the proper trunk link frame (connection 4) and the number group frame (connection 5).

4.149 From the number group, the marker obtains the line equipment location of the called number and connects to the line link frame on which it appears (connection 6). The marker then establishes a channel between the intertoll trunk and the called subscriber. After setting the proper ringing in the ringing selection switch, the marker releases its associated linkage and itself and leaves the incoming intertoll trunk in control of the call.

4.150 If the marker cannot find an idle channel between the trunk link frame and the line link frame, it sets the incoming intertoll trunk to return a reorder signal to the originating operator.

H. Multioffice Operation

4.151 A No. 5 crossbar marker group can handle a maximum of 20,000 directory numbers. A minimum of two office codes must be assigned when the office is equipped with more than 10,000 directory numbers. The number groups may be subdivided in any manner desired in blocks of 1000 between the two office codes, except that one office code cannot be assigned to more than 10,000 directory numbers. These two divisions are called office A and office B.

I. Physical-Theoretical Office Operation

4.152 Office A (maximum 10,000 numbers) and office B (maximum 10,000 numbers) can each be subdivided into three arbitrary groups of numbers called physical, theoretical, and extra theoretical, and each of these subdivisions will be assigned a distinct office name.

4.153 The major reasons for using additional offices in a marker group are:

- (a) To obtain discrimination between the number subdivisions for rate purposes.
- (b) To minimize subscriber number changes at the time of the initial installation or at some future time because of foreseeable central office rearrangements. (See 4.158 and 4.159.)

4.154 Whenever the subscribers served by one marker group are located in more than one political subdivision, with different tariffs, assignment

of a distinct office code to the subscribers in each such subdivision enables the equipment to provide distinctive charging and routing treatments. In this situation, incoming calls from distant wire centers are given a different charge treatment to the several office codes in the marker group. This discrimination feature prevents completion of calls on which distant subscribers dial the office code of the lowest charge in the No. 5 marker group, followed by the numerals of the office code desired. When such a dialing condition occurs, the calling subscriber is given a routing to an intercepting operator or a machine announcement.

4.155 When discrimination is used, the subscriber numbers associated with the physical, theoretical, and extra theoretical office codes are assigned in increments of 100 numbers and in any ratio desired. The hundreds blocks assigned to any one of these subdivisions need not be consecutive. There is one restriction namely, that an increment of 100 numbers cannot contain numbers of two or more subdivisions.

4.156 When discrimination is not used, any of the hundreds blocks may be arranged to complete the connection when the numerals are preceded by any one of the several office codes in the group of 10,000 numbers.

4.157 Usually where discrimination is used, one or more blocks of 100 numbers are arranged for nondiscrimination. These are called common numbers and are assigned to official lines, business office lines, test lines, etc.

4.158 Where one No. 5 crossbar marker group installation replaces more than one central office, the names associated with these replaced offices may be retained to eliminate wholesale number changes. The No. 5 crossbar equipment cannot, however, inherit directory numbers with party letters.

4.159 Additional office names may be used in anticipation of future growth. The subscribers who are ultimately to be served by new equipment are initially assigned a theoretical office code in the existing marker group. At the time when the new equipment is ready for use, the subscribers with the theoretical office code are transferred to the new equipment without a number change.

J. Intermarker Group Operation

General

4.160 Intermarker group operation is an efficient method of handling the traffic between two No. 5 crossbar marker groups located in the same building. The three types of intermarker group trunks for carrying this traffic are:

- (a) Subscriber to subscriber.
- (b) Subscriber to trunk.
- (c) Trunk to subscriber.

4.161 All these trunks have locations in both marker groups. Types (a) and (c) have trunk link frame locations in each marker group. Type (b)

has a trunk link frame location in the nontandem marker group and both line link and trunk link frame locations in the tandem marker group. This method is more efficient and economical than handling such traffic as regular interoffice traffic because the traffic between these marker groups is carried over intermarker group trunks and senders (using subscriber-to-subscriber trunks). This avoids using the conventional outgoing senders, incoming registers, and interoffice trunks.

4.162 The intermarker group sender serves both as an outgoing sender and as incoming register. It acts as an outgoing sender when it is connected to a calling marker and as an incoming register when it is connected to a called marker.

Method of Operation

4.163 The traffic between the two marker groups is of three types.

Type (1) - Subscriber to Subscriber

4.164 For calls that originate in marker group 0 and terminate in marker group 1 and vice versa, the trunks used are called subscriber to subscriber. These calls are routed over an intermarker group trunk which requires the use of an intermarker group sender. From the called code, the marker in the originating office determines that an intermarker group connection is necessary and proceeds to set up a connection to an intermarker group trunk. (See Fig. 52, attached, connections 1 and 2.) The marker also connects to an intermarker group sender and transmits the called directory number to it (connection 3). The calling marker interconnects the trunk and sender via a sender link (connection 4) and releases.

4.165 Now the intermarker group sender acts as an incoming register and connects to a marker in the called office via an incoming register marker connector (connection 5). The sender transmits the called number and the trunk link frame number in marker group 1 to the marker and releases. The marker, from this information, proceeds to set up a regular incoming call connection to the called subscriber (connections 6, 7, 8, and 9).

Type (2) - Subscriber to Trunk

4.166 For calls that originate in marker group 0 and require the use of marker group 1 as a tandem office to a connecting office, the trunks used are called subscriber to trunk. When no direct trunks are provided from marker group 0 to the desired destination or when the direct trunks are all busy and an alternate route is to be used, a call from marker group 0 to a connecting office is tandemed through marker group 1 in order to obtain an outgoing trunk.

4.167 Fig. 53, attached, shows a call to a connecting office from a subscriber in marker group 0. After the marker gets the called number, it recognizes that the required trunk is a subscriber to trunk. This trunk has trunk link and line link frame locations in marker group 1. The marker sets up a connection to the proper trunk (connections 1, 2, and 4), seizes an intermarker group sender (connection 3), and connects them to each other

through a sender link. The marker transmits the called number to the sender and releases.

4.168 Since the line link location of this trunk in marker group 1 is going to be used on the call, the trunk number (000 to 999) is obtained from various sources and is registered in the sender link. The sender link then transmits this number to the called marker through the incoming register marker connector (connection 5). The trunk also transmits its trunk link frame number to the sender which in turn transmits it to the called marker (connection 6).

4.169 The marker goes to the number group, and from the trunk number, obtains the line link frame location of the trunk (connection 7). The marker then seizes the line link frame on which the trunk appears (connection 8), and also seizes an idle trunk link frame which has an outgoing trunk (connection 9), and sets up a channel between them (connection 11). At the same time, the marker selects an outgoing sender (connection 10). The marker transmits the called number to the sender, connects the sender and the outgoing trunk through the sender link, and releases. The call proceeds like a regular outgoing call.

4.170 If the marker cannot obtain an idle outgoing trunk, it seizes the trunk link frame location of the intermarker group trunk (from the trunk link frame number) and sets it to return overflow signal to the calling office.

Type (3) - Trunk to Subscriber

4.171 For calls that originate in connecting offices and require the use of marker group 1 as a tandem or toll center switching point for reaching subscribers in marker group 0, the trunks used in this case are called trunk to subscriber. When incoming traffic is terminated at marker group 1, calls from connecting offices for subscribers in marker group 0 have to be tandemed through on an intermarker group basis. The coming trunks which are regular incoming tandem equipments have two locations in marker group 1; one on the line link frame and one on the trunk link frame. Just as for regular tandem calls, the line link location is used for calls going through the office and the trunk link location for calls terminating in the office.

4.172 As shown in Fig. 54, attached, the call starts out like a regular incoming call, going through the incoming register link and the incoming register to the marker (connection 1). Through this linkage, the following information is transmitted to the marker: the called directory number, the trunk number (000 to 999), and the number of the trunk link frame on which the trunk appears.

4.173 From the called office code, the marker recognizes that this call is to be tandemed through to marker group 0. First, the marker seizes an intermarker group sender (connection 2) and a trunk link frame (connection 3) with an idle intermarker group trunk (trunk to subscriber) and interconnects them through a sender link (connection 4). The marker transmits the called directory number and the trunk link frame number to the sender. Then the marker goes to the number group (connection 5), and by means of the trunk number, obtains the line link frame location of the incoming trunk. The marker seizes this location (connection 6), establishes a channel between the incoming trunk and the intermarker group trunk (connection 7), and releases.

4.174 The intermarker group sender seizes a marker in marker group 0 via a connector, transmits the called number and trunk link frame number to it (connection 8), and releases. The marker seizes the trunk link frame on which the trunk appears (connection 9). The marker then goes to the number group (connection 10), and from the called number, gets the line link location of the called line. After it seizes this location, the marker sets up a channel between the intermarker group trunk and the called subscriber (connection 12). The call proceeds from the incoming trunk through the intermarker group trunk to the called subscriber.

K. Direct and Alternate Route Arrangements in the No. 5 Crossbar System

Direct Routes

4.175 In a small- or moderate-sized exchange area, generally each local central office has direct trunks to all other central offices in that area. The trunks are usually provided on a one-way basis; that is, traffic in each direction is handled over a separate group of trunks. Such an arrangement permits the interconnection of any two subscribers in the exchange area.

4.176 When the marker is setting up an interoffice call, it determines whether a trunk link frame has idle trunks before seizing the frame. After a frame has been seized, the marker can test a maximum of twenty trunks at one time on the one frame. Since each frame is, therefore, limited to a maximum of twenty trunks per route, the total number of trunks per route in the marker group is limited to twenty times the number of trunk link frames. For example, if office X has five trunk link frames, the marker can determine if any of 100 trunks to office Y are idle by the single trunk link frame test.

4.177 In the above example, if the 100 trunks of office X (five trunk link frames) are not adequate to handle the amount of traffic to office Y, then more than 100 (but not more than 200) trunks are provided. The trunks are divided into two subgroups, 100 trunks maximum per subgroup. These subgroups are spread over the five trunk link frames, a maximum of twenty trunks of each subgroup on a frame.

4.178 Note that the subgroup in such an office cannot have more than 100 trunks because the marker is limited to testing twenty trunks after the frame has been seized. To use both subgroups effectively, the marker allots calls into each subgroup. This is done by testing one subgroup on one call to office Y and the other subgroup on an alternate call. If the marker tests for idle frames with idle trunks in one subgroup but finds no trunks available, it tests the second subgroup in an effort to complete the call successfully before routing it to overflow.

Alternate Routes

4.179 The alternate route principle is a combination of direct and tandem routing. Direct trunk groups are supplied from office X to office Y, but these groups are intentionally made inadequate to carry all of the traffic during heavy loads. Office X will always attempt to route calls over the direct group to office Y first, and, therefore, the high load on that group keeps it working efficiently. When all of the trunks of the direct group are in use and another call is originated to the same destination, the marker in

office X will attempt to complete the call over the direct group, but in this case will find all the trunks busy. The marker then attempts to complete the call over the alternate (tandem) route in the manner of a tandem call.

4.180 In large exchange areas where trunking becomes more involved, more than one alternate route may be available for a call; for example, office X can reach office Y over the direct route trunks, and also through tandem offices 1 and 2.

4.181 The markers in office X route calls for office Y over the direct route trunks as long as any of them are idle. Additional calls are then routed to office Y through tandem office 1. The route through tandem office 1 is called the first alternate route. If both direct route and first alternate route trunks test all busy, the markers in office X attempt to route additional calls for office Y through a tandem office 2 (second alternate route).

4.182 The No. 5 crossbar system can handle three alternate routes, in addition to the direct route. If a call cannot be completed over any of these routes, overflow tone is returned to the calling subscriber.

L. Operator Junctor Operation

4.183 Operator junctors are trunks that are located at the toll and DSA switchboard and on a line link frame and trunk link frame in a No. 5 office. (The trunk link location is used only for setting overflow signal.) DSA or toll operators use them to gain access to the outgoing trunks in the office, and thus switch a call through to a connecting office. Since the operator junctor is a type of tandem trunk, a No. 5 office must be equipped for tandem operation in order to use it.

4.184 In Fig. 55, attached, a calling subscriber reaches a DSA operator and gives her the called number. From this number, the operator determines the route for the call and plugs into an operator junctor. She then keys the called directory number into the trunk (connection 1) which is first connected to an MF incoming register through an incoming register link (connection 2). After the called number, the trunk number, and the trunk link location of the operator junctor are set in the incoming register, the register seizes a marker via an incoming register marker connector and transmits this information to it (connection 3). Directed by the trunk number, the marker goes to the number group and obtains the line link frame location of the trunk (connection 4).

4.185 The marker then seizes an outgoing sender through an outgoing sender connector (connection 5) and transmits the called number to it. By means of a trunk link connector, the marker seizes an idle trunk link frame and an outgoing trunk on that frame (connection 6), and connects the outgoing sender and the outgoing trunk through the sender link. Through a line link connector, the marker seizes the line link frame on which the operator junctor appears (connection 7). At this point, the marker sets up a channel between the operator junctor and the outgoing trunk. The sender transmits the required digits to the connecting office through the sender link and the outgoing trunk and then releases itself and the sender link. The marker releases upon completion of its functions, and the DSA operator has supervision of the call (connection 8).

M. Coin Junctor Operation

- 4.186 The coin junctor is a unit of equipment used for handling outgoing inter-office and subscriber-to-trunk intermarker group coin traffic. The plan is called coin junctor operation. Coin junctors can be used as alternate routes for groups of regular outgoing coin trunks. With this arrangement, outgoing trunks that handle coin and noncoin traffic do not need coin features.
- 4.187 On a call using the coin junctor arrangement the subscriber is connected to an outgoing trunk just as on a regular outgoing call. (See Fig. 56, attached, connections 1 to 5.) The marker instructs the outsender to outpulse the called directory number and releases. Now the call proceeds like an incoming tandem call. The called number and the trunk number are placed in the incoming register (connection 6). The register seizes a marker through a connector and transmits this information to it (connection 7). The marker seizes the number group (connection 8) and (from the trunk number) obtains the line link location of the tandem trunk. The marker then proceeds to establish a connection between this location and an outgoing trunk (connections 9, 10, 11, and 12). This outgoing trunk does not have any coin features but must have a tandem completing feature in order to return reverse battery supervision.
- 4.188 Two trunk circuits have been combined into one circuit which has both outgoing coin and incoming tandem features to make a coin junctor.

N. AMA Junctor Operation

General

- 4.189 AMA junctor operation is similar to the coin junctor operation and can be employed for subscriber calls originating in the No. 5 office and completing via outgoing interoffice trunks and also via outgoing intertoll trunks. The latter type of call will be encountered with foreign area customer dialing (FACD) and may also be encountered on the long haul calls within the home numbering area (HACD).

AMA Junctor Operation With Outgoing Interoffice Trunks

- 4.190 Where trunk groups handle a small percentage of AMA billed calls and the rest are noncharge, the AMA junctor method can be used to permit more economical equipment arrangements. From the standpoint of equipment arrangements, the AMA junctor is assembled from an AMA outgoing trunk and an incoming tandem trunk.
- 4.191 On a call using the AMA junctor arrangement, the subscriber is connected to the outgoing AMA trunk in the regular manner. The out trunk and outsender call in the AMA equipment to record the necessary details of the call. The associated incoming tandem trunk then calls for an incoming register and the digits are transferred to it. The call is then routed through the frames the second time (like any other tandem call) to the tandem-type non-AMA out trunk.
- 4.192 Answering supervision is returned to the AMA trunk when the called subscriber answers and a suitable entry is made on the tape. When the call is terminated another entry is made on the tape and all connections are released.

AMA Junctor Operation With Outgoing Intertoll Trunks

4.193 As outgoing intertoll trunks are primarily used by operators, they do not contain AMA arrangements nor provision for supplying talking battery supply. Accordingly, when subscribers are given direct access to these trunks with FACD service, the required AMA and talking battery supply arrangements are obtained by associating an auxiliary trunk with the intertoll trunk. Where trunk groups handle a small percentage of subscriber dialed calls compared with operator-handled traffic, it may be more economical to use AMA junctor operation than to furnish the auxiliary trunks. In this case, the equipment arrangements of the AMA junctor are assembled from an AMA outgoing (loop signaling type) trunk and an incoming intertoll (reverse battery signaling type) trunk.

4.194 The method of operation for the AMA junctor for intertoll trunks is similar to that described for interoffice trunks above.

0. Selection Preference

Selection Preference for Vertical Groups, Horizontal Groups, and Vertical Files

4.195 To assure equal service for all the lines on a line link frame, a circuit arrangement is provided which rotates the order of the marker's preference for serving calling lines one step for each call or connection. The preference chain is fixed but the point of entry is different each time.

4.196 When a marker seizes a line link frame in order to set up a dial tone connection, it follows a fixed selection preference for serving vertical groups, horizontal groups, and vertical files. The only exception to this change of preference is vertical group 02 which is always served first. Police, fire, and other emergency lines appear in this vertical group. The selection preference feature solves the problem of giving an equal grade of service to all lines when simultaneous demands for dial tone occur. The marker serves one call at a time in accordance with the selection preference sequence and any other call has to wait its turn.

4.197 The sequence of the selection preference of vertical groups on a dial tone job depends on the number of vertical groups on the line link frame. This number may vary from six to twelve depending on how many lines there are on the line link frame.

4.198 When a marker serves a dial tone job on such a line link frame, it immediately looks at vertical group 02. If there is a call on one of the lines in that group, the marker serves it; if not, the marker attempts to serve calls in other vertical groups. The marker proceeds in this manner until it finds a call waiting, for example, on vertical group 03. Then the marker looks at the horizontal groups in vertical group 03 in the sequence 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, and at the vertical files in the sequence 0, 1, 2, 3, 4.

4.199 The entry point on each of these preference sequences is changed with each marker use.

4.200 Because the number of horizontal groups and vertical files in a vertical group is constant, the selection preference sequences for these remain constant.

4.201 On the other hand, the number of vertical groups depends on the capacity of the line link frame; therefore, the selection preference sequences vary according to the number of vertical groups.

Selection Preference for Originating Registers and Trunks

4.202 When setting up a connection, the marker seizes a trunk link frame with at least one idle trunk. If there are several idle trunks on the frame, the marker must select one for service. In order to distribute the traffic uniformly over all the trunks in the office, a method of rotating the selection preference, similar to the one for vertical groups, horizontal groups, and vertical files, is used. Since the trunks on a trunk link frame which are associated with the same route are grouped on a trunk block relay which can serve twenty trunks, a 20-step selection preference sequence is used for selecting the idle trunk.

4.203 The marker selects the trunk link frames in numerical order, but if idle trunks are available on several frames, the first preference advances one frame for each marker use.

4.204 A similar method of selection preference applies to originating registers.

P. Code Conversion

4.205 When calls outgoing from a No. 5 office are given a trunk routing through an intermediate step-by-step office to several connecting offices, it may be necessary to outpulse, from the No. 5 office to the intermediate office, code digits which do not correspond to the directory code digits received by the No. 5 office marker from a subscriber or an operator. This conversion of codes is required where the trunking arrangements of the step-by-step selectors are on an arbitrary code basis.

4.206 Dial pulse outgoing senders are arranged (optionally) for a maximum of three arbitrary digits from which full flexibility in one-digit, 2-digit, and 3-digit arbitrary codes can be obtained. The arbitrary codes can be substituted for the directory codes (code conversion), or they can be prefixed ahead of directory codes.

Q. Calls Involving Equipment Irregularities

Stuck Originating Registers

4.207 An originating register may be stuck in such a way that after dialing is completed, it cannot obtain a marker. In this case, the register times out and releases itself and the dialing connection after 19 to 37 seconds. The originating subscriber is then given another dial tone connection. During periods of heavy traffic, the time-out period is reduced to 10 to 18 seconds.

4.208 If the originating register is stuck in such a way that it cannot register any of the dialed digits, the call is treated as a permanent signal.

4.209 If the originating register is stuck in such a way that it registers just some of the dialed digits, the call is treated as a partial dial.

Stuck Outgoing Senders

4.210 An outgoing sender, which is being used in an outgoing connection, may not be able to output because of an equipment irregularity. In this case, a DP or RP sender times out after 19 to 37 seconds (a MF sender times out after 13 to 25 seconds), sets the outgoing trunk to give reorder signal to the calling subscriber, and releases itself from the connection.

4.211 If the trunk test which the sender performs fails, the sender goes through the above procedure.

Stuck Incoming Registers

4.212 An equipment irregularity may prevent (a) an incoming register from calling in a marker or (b) from transmitting the called number to a marker after the register has seized one. In the first case, under normal traffic conditions, a DP, RP, or MF register times out after 19 to 37 seconds and the register releases from the incoming trunk. In the second case, the marker having been seized and lacking receipt of the call information, will time for 0.25 to 0.45 or 2.6 to 4.3 seconds, depending upon what information is missing, and then signal the incoming register to make a second attempt. If this attempt fails, the marker signals the incoming register to release, and if conditions permit, signals the incoming trunk to return a reorder signal to the originating end.

4.213 The time-out period for the DP incoming register is reduced to 4.4 to 8.4 seconds during heavy traffic; the time-out period for MF registers remains the same.

4.214 A stuck revertive pulse incoming register does not go to the marker but signals the outgoing sender in the originating office to set up the reorder signal in the trunk.

Marker Irregularities

4.215 If for any reason, while handling a call, a marker encounters a trouble condition, it signals its associated marker connector to select another marker. If the second marker encounters trouble, the above process is repeated. In this way, as long as there is an off-switchhook condition on the calling subscriber line, the line link marker connector continues to select a marker until the subscriber hangs up or the call is completed.

4.216 Before it releases, each marker which encounters trouble calls in the trouble recorder to take a trouble record.

Faulty Switchhook Manipulation

4.217 Faulty switchhook manipulation may cause one or more preliminary pulses (ones) to be transmitted to the originating register before the normal dial pulses. The originating register disregards these preliminary "ones" and does not register anything in the A digit until a digit of two or more pulses is received. (If an office uses an llX code, special provision is made for recognizing the first two digits.)

5. EQUIPMENT ARRANGEMENTS

5.01 There are certain practices in equipment arrangement which are followed in almost all offices. The frames are placed in a logical order. The line link and trunk link frame line-ups are usually placed close together to simplify the cabling between these frames and a junctor grouping frame which is common to them. For the same reason, the trunk link connectors are placed near the trunk link frames. The testing and maintenance frames are located in a central spot for easy accessibility.

5.02 The basic framework is the same throughout the No. 5 crossbar system: the frames are 11-1/2 feet high, 10-1/2 inches deep, and their width varies from 20-1/2 to 45 inches. Generally, they are arranged with the apparatus sides of two frame line-ups facing each other with a 2-foot, 6-inch aisle between them. The wiring aisle between the backs of the frames are about 23 inches wide.

5.03 Covers are provided for the front of certain frames to exclude dust from the apparatus. There are metal covers for some equipment units and transparent plastic covers for others. When the equipment units are enclosed with front covers, front horizontal baffles are provided to prevent the distribution of dust and the spread of fire. Rear baffles are provided with rear covers.

5.04 An end guard, which is a metal panel, is placed on the side of the frame at the end of a frame line-up. The aisle pilot lamps for the alarm systems are mounted on these end guards at the main aisle end of the line-up. There is also space for mounting the frame distributing fuses at the top of the end guard panel.

5.05 The front of each frame is stamped with its name and number. In addition, each line-up has designation cards to identify each frame and its position in the line-up.

5.06 In order to trace the interconnections between the circuits mounted on these frames, designation cards which contain this information are provided for various frames.

6. MAINTENANCE FEATURES

A. General

6.01 The basic provisions for maintenance of No. 5 crossbar system offices consist of testing equipment for the various circuits and associated apparatus, arrangements for providing notice of and information about failures

occurring on service, and test calls and means for removing equipment from service. In addition, testing equipment is provided for use in the maintenance of the subscriber line plant and of trunks terminating in other buildings.

6.02 The majority of the equipment required for the maintenance features is mounted on bays which collectively are called the "master test frame." The remaining apparatus is mounted on other equipment bays or frames or in portable test boxes.

6.03 The master test frame bays, shown in Fig. 57, are required in every office. They are located in the maintenance center since most of the apparatus required for operating and administering the testing and other maintenance features associated with the master test frame is mounted thereon. This apparatus includes a recording device which automatically provides information in the form of punched cards concerning failures on service calls and also regarding the results of certain test calls. Views of an unpunched card and a punched card are shown in Fig. 60, attached.

6.04 A basic 2-bay frame is provided as part of the master test frame in every office for the purpose of connecting to as many as six completing markers. An auxiliary bay is provided for each three additional markers. A separate connector bay is provided for connecting to dial tone markers. These connector bays shown in Fig. 59, attached, will be placed in some convenient location but not necessarily in or close to the maintenance center.

6.05 From one to four additional frames may be required depending on the type of testing equipment desired for the senders and registers and upon the types of senders and registers to be tested. These bays which will also be located in some convenient location on the maintenance center floor are shown in Fig. 58, attached.

6.06 The following choice of testing equipment for the senders and registers is available:

(a) Arrangements providing extensive tests of the circuits including the use of permanently located apparatus for automatically producing digits or selections using pulses which are precise as to speed or ratio of open to closed intervals and also including registering devices for receiving the output of senders.

(b) Simple testing equipment employing portable test sets which impose marginal tests only where a small expense in apparatus is required and which, in general use, requires that digit and selection pulses be produced by manually operating a dial or keys. Some auxiliary apparatus is required and is located on the master test frame. With such an arrangement, a pulse generator capable of producing pulses which are accurate as to speed and length of pulse and which can be varied over a considerable range will be required for occasional conditioning purposes. Such a generator is available in portable form.

6.07 The choice of testing arrangements can be made for each type of sender or incoming register, except for tandem revertive incoming registers. For these registers only the simple type of testing equipment is available.

6.08 The more complete type of testing equipment is a dual purpose arrangement which permits its use as a means for automatically monitoring on the senders and registers while they are being used on service calls. Failures indicated during this monitoring process causes the trouble recorder to make a record of the conditions and of the circuit units used on the call.

6.09 In addition to the trouble recorder mentioned previously, the following apparatus is mounted on the four basic bays located at the maintenance center.

- (a) Keys, lamps, and other apparatus for directing test calls to the circuit or combination of circuits to be tested, for controlling the actual testing functions and denoting the progress of the test call, and for controlling arrangements for monitoring on senders and registers. Certain testing functions are also included in the control circuit.
- (b) The apparatus required for making tests of trunk circuits.
- (c) Lamps for indicating certain trouble conditions which do not cause an automatic record to be made and other lamps which indicate the duration of use of certain of the circuits.
- (d) Lamps and jacks associated with permanent signal holding trunks, common overflow trunks, and plugging-up lines.
- (e) Jacks for taking out of service units of the common control equipment.
- (f) Test and make-busy jacks for outgoing trunks.
- (g) A voltmeter circuit for use in testing subscriber lines and outgoing trunk circuits.
- (h) Communication trunks including a telephone circuit and a dial.
- (i) Plant peg count registers.

6.10 Some of the other testing equipments used in No. 5 crossbar offices are as follows:

- (a) A manually operated outgoing trunk test frame for use where the number of outgoing trunks is large.
- (b) A No. 18B toll testboard for use in maintaining intertoll trunks.
- (c) Test lines for use in making tests of the operating and signaling features of local and intertoll trunk circuits.
- (d) Test lines for making 1000-cycle one-way transmission tests of local and intertoll trunks.
- (e) A test line for making a balance test of intertoll trunk circuits.
- (f) Means for applying 100 operation tests to subscriber message registers.

(g) A test circuit for checking foreign area translator code cross connections.

(h) Several portable test sets.

(i) Testing arrangements required for use in the maintenance of the subscriber lines consisting of:

(1) An automatic line insulation test circuit.

(2) Station ringer test arrangements.

(3) Trunks to the local test desk.

(4) "Test" and "no test" trunks by way of which the subscriber lines can be reached from local test desk positions.

(5) A circuit under control of the test desk for providing access to permanent signal holding trunks and plugging-up lines.

6.11 An alarm system giving audible and visual signals is provided by means of which the central office force is advised of the occurrence of trouble conditions and directed to the proper location. The direction is accomplished by a pilot lamp indicating the floor involved, pilot lamps at main aisles, at cross aisles, and at the aisle to which the attention should be directed. Individual lamps are provided on equipment frames or on the master test frame as needed. Arrangements are available for transferring alarm indications to some other point in the same or another building when the office is to be unattended.

6.12 Except for the simplified testing arrangements, the uses and operation of the various features of the master test frame are described in Section A770.201 and no further description is given herein.

6.13 General description of the simplified testing arrangements, testing equipment for message registers, and arrangements for testing of the subscriber station ringers and of the general central office alarm circuits are given in the following paragraphs.

B. Test Set-type Testing Arrangements for Registers and Senders

6.14 A portable test set is provided for use in testing both originating and incoming registers. This test set is provided with two standard dials, one in the 8 to 11 pulse per second range and one in the 16 to 19 pulse per second range. A keyset is also provided for use in testing MF incoming registers. The dials are used for testing both originating and dial incoming registers. Some additional control keys and lamps are also provided.

6.15 Access to originating registers is obtained by the master test frame in the same manner as when the more complete test equipment is provided. The portable test set is then connected to the registers by way of the master test frame. The dials on the test set are then used to send the test code and number into the register. The results of the test are shown on a trouble recorder card.

6.16 Access to incoming registers is obtained by way of a control circuit provided when the portable set is to be used. This control circuit is mounted on the master test frame. The test set is connected to the control circuit and some other auxiliary apparatus, to a source of multifrequency for use when testing MF registers, and to a source of battery and ground by way of multiconductor patching cord and jack. When testing revertive incoming registers, the keyset is used to control the number of revertive pulses expected for each selection. As for originating registers, the results of tests of incoming registers are shown on a trouble recorder card.

6.17 A separate portable test set is provided for testing outgoing senders and a separate auxiliary relay circuit is also required for each type of outgoing sender; that is, dial, MF, revertive, and PCI. Access to the sender is obtained by way of the master test frame as when the more complete test arrangement is used.

6.18 Test connections are made as described for the registers, although for this test set two multiconductor patching cords are needed.

6.19 The test set is provided with lamps which light as dial, MF, or PCI pulses are transmitted by the sender. In the case of revertive senders, the pulses are transmitted by the auxiliary relay circuit, and the lamps record the number of pulses required to cause the sender to open its fundamental circuit on each selection. In the case of MF senders, the pulses are transmitted by the sender into a MF receiver from which the test set gets its information. This receiver can be the one which is normally associated with a MF incoming register. If such registers are not provided, a receiver must be provided for testing purposes.

6.20 The portable test sets can be used at the master test frame, or by a tie line arrangement, at the location of the circuit being tested.

C. Electronic Pulse Generator

6.21 The electronic pulse generator is a portable device arranged so that pulses (opening and closing of a circuit path) at any desired speed and ratio of closed to open periods over a reasonably large range can be obtained. This generator can be used to transmit dial, MF, or revertive pulses having the desired characteristics. The purpose of this generator is to provide means for making an occasional marginal test of senders and registers without making it necessary to provide pulse generating equipment for the purpose in the master test frame in every office.

D. Testing Equipment for Subscriber Message Registers

6.22 The testing equipment for subscriber message registers is contained in or is associated with a trunk circuit. Access to the message register circuit which is connected to the sleeve lead of the subscriber line circuit is obtained by originating a test call to the subscriber line by way of the trunk circuit.

6.23 In addition to apparatus required for establishing and supervising connection to a subscriber line, the trunk circuit contains a synchronous motor-driven interrupter for applying tests exactly 100 times, switches and

other apparatus for adjusting test voltages, a voltmeter and jacks for use in measuring the voltages, and relays for recording indications of whether the number is cross-connected for a tip or ring party or for an intermediate line in a terminal hunting group. A keyset is provided in offices where a MF incoming register is used for the establishment of the test connections.

6.24 Associated with the trunk circuit and having multiple appearances on all message register frames are three jacks, three lamps, and one key. One jack is used for originating test calls and the other jacks for associating test sets for message register testing. The key is used to apply full voltage rather than the operate or nonoperate voltages. The three lamps provide an indication of the number cross connections.

E. Arrangement for Testing Subscriber Station Ringers

6.25 Tests of station ringers are made in somewhat the same manner as in other dial systems; that is, a station ringer test circuit is reached by dialing and then the receiver is replaced after which the ringing current is applied. The ringing is stopped by again taking the receiver off the hook.

6.26 For the No. 5 crossbar system, a special code is dialed followed by the number assigned to the station under test. The code causes a connection to be established between the line and a ringer test circuit.

6.27 The number which is dialed causes the marker to set the ringing selection switch associated with the selected circuit for the kind of ringing which the station should receive.

F. Central Office Alarm System

6.28 The central office alarm system provides audible and visual signals as needed to notify the maintenance force of the occurrence of trouble conditions and of the location of the equipment in trouble.

6.29 Each aisle is equipped with a red aisle pilot lamp for indicating major alarms involving that aisle and a green aisle pilot lamp for indicating minor alarms.

6.30 The same general arrangement of cross aisle, main aisle, and other floor and exit pilots as has been used previously is provided. Similarly, an individual lamp indicating the equipment causing the alarm is provided.

6.31 The audible signals are those which have been standard for other systems namely:

- (a) Tone bar for major alarms.
- (b) Subscriber sets for minor alarms.
- (c) Subscriber set for alarm battery fuse alarms.
- (d) Loud ringing bell for indicating power failures affecting substantial amounts of equipment.

G. Automatic Line Insulation Test Equipment

6.32 The primary function of this equipment is to automatically scan subscriber lines for defects which manifest themselves as low insulation resistance. (See Fig. 61, attached.) A secondary function (optional) is its use for making certain traffic measurements. In regard to the latter, it is arranged to automatically scan line links and trunk links at regular intervals and to record the number of links found busy.

6.33 When used for testing subscriber line insulation, it tests about 12,000 lines per hour and records the line link equipment number of the lines failing to meet the test conditions, on the trouble recorder of the No. 5 office, or transmits the data to a teletypewriter page printer at the local test center.

7. GLOSSARY

A and B Appearances For Trunks on Trunk Link Frame: These are the two possible trunk switching connections on a trunk link frame. Trunks are assigned to these appearances according to the traffic engineering practices of an office. Originating registers are always assigned to the A appearances.

Alternating Routing: A method of advancing a call at any point by diverting it to a trunk group, other than the first choice group, when the first choice group is busy. Arrangements for three alternate routes are provided.

Assistance Call: A call which the subscriber could or could not dial directly but on which he dials zero to contact the operator for assistance.

Automatic Message Accounting System or AMA System: An equipment arrangement for recording and processing on continuous tapes the data required for computing telephone charges on customer dialed calls and calls handled by operators where provision is made for treating these calls in a similar manner. The system may include provision for compiling all charges and credits which affect the customer's bill and the automatic printing of the bill.

Automatic Monitor: A unit of equipment which attaches itself to registers and senders on a progressive basis; records without distortion the signaling input and compares this with the output. It calls in the trouble recorder for recording any incorrect operation. It may be used under manual control for testing senders and registers.

Blank Number: A number outside the assigned capacity for a particular office.

Call Versus Job: The word call is used only if the function is inclusive of all equipment. (See Job.)

Central Office Code: A code consisting of the one, two, or three digits or letters which appear in front of the numerals of a directory number. The central office code identifies a particular office within an exchange area.

Channel: A combination of a line link, a junctor, and a trunk link which, by crosspoint closures, forms a path to connect a line with a trunk or a trunk with a trunk.

Channel Number: A composite number identifying the line switch horizontal number of the line link, the trunk switch vertical number of the trunk link, and the junctor switch number in a channel.

Charge Delay Interval: An extended interval of time (2 to 5 seconds), maintained in the control of message charging, to insure against possibilities of errors due to transients or other conditions to short time duration.

Class of Service: The commercial term applying to the subgrouping of subscribers for the sake of rate distinctions. This subgrouping may, for example, distinguish between individual and party, between business, residence, and coin, between flat rate and message rate, between restricted and extended scope. In equipment and traffic engineering, it is used to refer to the subgrouping of lines for originating service for the sake of equipment operation distinction, independently of whether rate distinctions are involved; for example, in dial operation, lines may be subdivided into PBX and non-PBX classes to permit proper use of the howler on permanent signal conditions.

CLR Operator: A toll operator who performs the following duties:

- (a) Answers the call when the subscriber dials the 211 long distance code.
- (b) Writes the toll ticket using the information furnished by the subscriber.
- (c) Makes attempts to reach the called party while holding the calling party.
- (d) Times the call if connection is established.
- (e) Passes the ticket to the designated TX operator if the initial attempts fail and she dismisses the subscriber.

Code Conversion: Converting a directory or toll directing code into an arbitrary code for controlling the selection of a trunk route at a distant switching point.

Code Point: A terminal punching located in a cross-connection field in the marker and energized by registration of a 1-, 2-, or 3-digit code.

Code Ringing: Party-line ringing wherein the number of rings, or their duration, or both, indicate which subscriber is being called.

Coin Service: A public, semipublic, or subscriber class of service which has a coin-collecting device as part of the station equipment.

Coin Supervisory Link: A switching arrangement for connecting originating dial equipment to coin supervisory circuits.

Coin Test: A test made by either the originating register or coin supervisory circuit to establish the presence of a coin in the trap of a coin station subset.

Combined Toll and Dial System A Switchboard or Toll and DSA Switchboard: A local dial office switchboard which handles toll assistance calls, intercepted calls, and calls from miscellaneous lines and trunks.

Common Control Equipment: All switching equipment exclusive of line link frames and trunk link frames.

Connector: A relay-type switching device for interconnecting, for a short interval of time, two equipment elements over a relatively large number of leads.

Dial Pulsing or DP: A system of d-c pulsing in which the digits are transmitted by the interruption of the d-c circuit a number of times, one to ten corresponding to the digits one to zero on the dial.

Dial System B Switchboard or DSB Board: A switchboard of a dial system for completing incoming calls received from operators over straightforward or call circuit trunks.

Dial Tone: A tone used in dial telephone systems to indicate that the equipment is ready for the dialing operation.

Directing Code: Digits, such as 11, XOX, and XLX, dialed ahead of the directory number of the called station. These will enable a subscriber or operator to dial a number in an area next to or near the basic numbering plan area of the subscriber or operator.

Directory Number: The full complement of digits required to designate a subscriber in the directory. In a 5-, 6-, or 7-digit exchange area, the directory number consists of the office code followed by four numerals. In some areas a station letter, to control selected ringing, follows the four numerals and is considered part of the number.

Divided Ringing: A method of obtaining partial ringing selectivity by connecting one half of the ringers from one side of the line to ground and the other half from the other side of the line to ground. This term is not ordinarily applied to selective and semiselective ringing systems.

Exchange: A unit of a telephone company used for the administration of service in a specified area which usually embraces a city, town, or village, and its environs. It consists of one or more central offices together with the associated plant used in furnishing communication service in that area. Ordinarily an individual local tariff is filed for each exchange.

Exchange Area: The territory included within the boundaries of an exchange.

Extheo: Contraction of the words "extra" and "theoretical." (See definition of theoretical number.)

Flat-rate Service: A subscriber classification of local service in connection with which a stipulated monthly charge is made covering all message use to stations within a specified area.

Foreign Area: A numbering plan area other than the numbering plan area in which a calling subscriber is located (see Numbering Plan Area).

Foreign Area Translator: An equipment frame and associated circuits common to a marker group, used in conjunction with the markers for translating the office codes of a foreign area for routing purposes when there is more than one trunk route available for entry into the foreign area.

Free Code Call: A call which the terminating equipment recognizes from the code dialed as one to be handled on a free service basis.

Home Area: The numbering plan area in which a calling subscriber is located.

Horizontal Group: All of the lines served by the same ten line links.

Incoming Register: The register which receives the pulsing (dial, multi-frequency, or revertive) from the incoming trunk and transmits it to the marker through an incoming register marker connector.

Incoming Register Link: A switching arrangement for connecting incoming trunks to incoming registers.

Incoming Trunk: A trunk incoming to a local central office switching unit for use in terminating calls on the subscriber lines of that unit. Also, a trunk incoming to a local toll, tandem, or PBX switchboard or switching unit.

Interoffice Trunk: A trunk between two switching units regardless of type. This term is confined largely to trunks between local offices in the same exchange area.

Intertoll Office Trunk or Intertoll Trunk: A trunk between toll switchboards or toll switching systems in different offices.

Note: Where combined toll and local switchboards are involved, the trunks are classed as intertoll or interlocal, depending upon whether the switchboards in question are performing toll switchboard or local switchboard functions in handling the traffic over these trunks.

Intraoffice Trunk: A trunk between two points in the same central office or switching unit where the unit serves more than one central office.

Intermarker Group Trunk: A trunk between two marker groups located in the same building. There are three types of these trunks:

- (a) Subscriber to subscriber.
- (b) Subscriber to trunk.
- (c) Trunk to subscriber.

Inward and Through Toll Position: An inward and through toll position is used primarily to receive calls over intertoll trunks and to establish inward connections to local subscribers or to extend through connections to other intertoll trunks. In certain cases, the inward function and the through function may be performed at separate positions.

Job: A specific function attributed to the marker. (See Marker Job.)

Junctor: A talk circuit extending between frames of a switching unit and terminating in a switching device on each frame.

Junctor Group: The juncctors which extend from a particular line link frame to a trunk link frame. The size of the junctor group depends on the number of trunk link frames or pairs of trunk link frames.

Junctor Grouping Frame: A frame which functions to facilitate the distribution of the 100 juncctors from each line link frame to all of the trunk link frames so that each line link frame will have equal access to all trunk link frames.

Line Link: A switching arrangement for connecting subscriber lines to juncctors on originating calls and juncctors to subscriber lines or trunks on terminating or through calls.

Line Link Frame: A frame containing line links with associated equipment and subscriber line relays.

Local Central Office or Local Office: A switching unit in a telephone system serving primarily as a place of termination for subscriber lines. It has a maximum of 10,000 numbers. Services can be provided on both a physical and theoretical office basis. This arrangement is considered as one local central office.

Local Service Area: The area within which are located the stations which a subscriber may call at local rates in accordance with the provision of the local tariff.

Main Distributing Frame or MDF: A structure for terminating the permanent inside and outside wires in a central office, and for effecting flexible connections between them. It generally carries the central office protective devices and functions as a test point between line and office.

Marker: Equipment which establishes communication paths between calling subscribers and trunks, between trunks and called subscribers, and between trunks.

Marker - Completing: A marker which performs all marker operations except the dial tone stage.

Marker - Dial Tone: A marker which performs marker dial tone stage operations only.

Marker Group: A common group of markers which serves one or more central offices. A marker group may serve as many as 20,000 numbers. For administrative and statistical purposes where provision is made for serving more than 10,000 directory numbers with common control equipment, each group of 10,000 numbers is considered a separate central office. A central office may serve some subscribers on a theoretical basis with additional office names and codes. Such a theoretical office arrangement is not considered as a separate central office. The terms office A and office B refer to each half of the 20,000

numbers in describing the functions of the switching circuits of the marker group. (The term marker group is also used to refer to the equipment served by a marker group.)

Marker Job: The single marker usage (from seizure to release) involved in completing any one of its designated functions.

Marker jobs are accordingly indicated as:

- (a) Dial Tone Job
- (b) Intraoffice Trunk Job
- (c) Outgoing Trunk Job
- (d) Incoming Trunk Job
- (e) Reverting Trunk Job
- (f) Toll Trunk Job
- (g) Tandem Trunk Job

Master Test Frame: A unit of equipment which provides for the testing of the equipment units of a marker group.

Master Test Frame Connector: A connector by which markers and other equipment obtain access to the master test frame.

Message Rate Service: A subscriber classification of local service which is measured in terms of messages or message units for the purpose of charging for the service.

Message Register: A counting device which records message units on originating traffic for calls to points within the one message unit charge area. In the No. 5 crossbar system, message registers can be used only in connection with individual and 2-party message rate classes of service.

Message Unit: The unit of measurement for charging for message use by the translation into equivalent message units of ticket or AMA charges for calls within a specified area.

Multifrequency Pulsing or MF: A method of pulsing in which the identity of the ten digits, zero to nine, and the start and end signals are each determined by various combinations of two each of six frequencies. The two frequencies for each digit or signal are transmitted simultaneously over the trunk.

No-hunt Call: A call, made from the outgoing trunk test frame or the message register rack, which will not hunt in a terminal hunting group. If the line associated with the dialed number is busy, busy signal is returned.

Nondiscriminating Number: A number associated with two office codes. Such a number is reached regardless of which of the two codes is dialed.

No-test Call: A call from an operator or a test desk man which will connect to the dialed subscriber line regardless of whether or not it is busy. If the line is idle, the connection is established through a channel, and if the line is busy, the connection is established through the no-test connector and a no-test vertical on the line link frame.

No-test File: The ten vertical units which are used for no-test operation and are located one above another on a line switch bay of the basic line link frame. On a split line link frame, the no-test files are located one above the other on five switches on the left and five switches on the right.

No-test Vertical: Vertical file 0 in vertical group 2 of each line link frame contains ten no-test verticals. These no-test verticals are used when a connection is established between a busy line and a no-test trunk through the no-test connector. No-test verticals 0 to 4 are multiplied, and also no-test verticals 5 to 9, so that only two no-test calls may be simultaneously established, through the no-test connector, between no-test trunks and busy line of one line link frame.

Number or Numericals: The digits which identify a subscriber in a central office. A letter suffix, a requirement in some offices, is considered part of the numerals.

Number Group: A group of 1000 consecutive directory numbers, within one numerical thousand, which is treated as a unit by a marker in setting up an intraoffice, incoming, or tandem call.

Numbering Plan: The arrangement of digits as listed in local area directories; for example, a directory number with three code digits and four numerals is in a 7-digit numbering plan.

Numbering Plan Area: The United States and Canada are divided into a total of 92 numbering plan areas. In general, the subdivisions follow state and province boundaries. However, where there is a high telephone density, a state or province may have two or more areas within its geographical boundary. Each numbering plan area is assigned a national code in the XOX and XLX code series. Within a numbering plan area there can be no office code conflicts.

Office A - Office B: The terms which refer to each of the two 10,000 number series in a marker group. (See Marker Group.)

Office Selector Tandem: A group of distant office selectors controlled from the originating office or from a sender tandem. (See Panel Tandem Office.)

Operator - Completing Trunk: A trunk at the DSA switchboard over which the operator can complete assistance calls both to a subscriber served by the office in the building or to an outgoing trunk from that office.

Originating Register: A register connected to a subscriber line via line and trunk links for giving dial tone and for recording the subscriber dialed pulses.

Originating Stage: That portion of the switching process involved in extending the connection from the selected intraoffice trunk to the originating line. The originating stage is a subdivision of the marker intraoffice trunk job.

Outgoing Trunk: A trunk used for calls terminated outside a switching unit.

Outward Toll Position: An outward toll position is arranged to receive primarily toll calls from subscribers, and to complete, time, and ticket such calls. These positions may also handle DSA traffic.

Overflow Tone: A tone returned to the calling subscriber to indicate the call could not be completed because the marker was unable to find an idle channel, outgoing sender, or trunk to use in the connection. Overflow tone is usually interrupted 120 times per minute.

Panel Call Indicator Pulsing or PCI Pulsing: A system of d-c pulsing in which each digit is transmitted as a series of four marginal and polarized impulses.

Panel Tandem Office: Panel tandem offices are of two general types as follows:

(a) Sender Tandem: Tandem and completing office selections are controlled by a sender in the tandem office. This sender gets its setting either from a tandem operator's key (operator tandem) or from another office in the form of pulses (full selector tandem).

(b) Office Selector Tandem: See above.

Partial Dial or Partial Digits: A failure of the originating register to receive sufficient digits to complete the call. It may result from a subscriber dialing before dial tone, or failing to dial sufficient digits after receiving dial tone.

Party Line: A subscriber line arranged to serve more than one main station. Provision is made for discriminatory ringing with respect to the parties on that line.

Permanent Signal: The condition caused by the operation of a line relay followed by no dialing. After a measured interval, the subscriber line is connected to a permanent signal trunk in order to conserve register usage and to insure proper maintenance action in case of trouble on the line.

Physical Number: An arbitrary designation for the numbers associated with only one of three office codes, using the same 10,000 number series. The numbers associated with the other office code only are designated as theoretical numbers, or extheo numbers.

Physical-Theoretical Discriminating Features: The feature which indicates to the marker whether the physical or the theoretical office is wanted, and whether the number is a physical or a theoretical number.

Pretranslation: This operation takes place after a fixed number of digits (usually the office code) have been recorded to determine how many additional digits (if any) are required for the complete translation of the directory number. This feature is designed to reduce time delay in transmitting the call from the register to the marker where the total number of digits of the directory numbers in one office varies.

Pulse Conversion: The operation of changing, when necessary, the type of pulsing between connecting offices in order to meet their particular transmission requirements.

Pulsing: The act of transmitting digit information over a circuit to a switching unit for the purpose of reaching a called subscriber or operator. The various kinds of pulsing used in the No. 5 crossbar system office with interconnecting offices include:

- Dial (DP)
- Multifrequency (MF)
- Panel Call Indicator (PCI)
- Revertive (RP)

Recycle: The action which releases the initially selected trunk and permits an attempt to establish the connection to another trunk of the same route but using a different group of junctors and trunk links.

Reverting Call: A subscriber-dialed call between two subscribers served by the same subscriber line.

Revertive Pulsing or RP: A system of d-c pulsing in which intelligence is transmitted in the following manner:

- (a) The near end presets itself in a condition representing the number of pulses required and in a condition to count the pulses received from the far end.
- (b) The terminating end transmits a series of pulses by momentary grounding out of its battery supply until the originating end breaks the d-c path to indicate that the required number of pulses have been counted.

Reverting Call Trunk: A trunk used to set up a talking channel for a reverting call.

Selective Ringing: A party-line ringing system where the bell or bells of the desired party only are rung. The No. 5 system is designed to utilize individual 2- and 4-party, full-selective ringing.

Semiselective Ringing: A party-line ringing system where the station bells of two parties are rung simultaneously, differentiation being made by a one-ring, 2-ring code. The No. 5 system is designed to utilize 4- and 8-party semi-selective ringing.

Sender: A unit of equipment in the dial switching system which receives pulses from the marker and transmits these pulses to a distant office.

Sender Link: A switching arrangement for connecting outgoing senders and trunks.

Service Code Call: A subscriber call to a service desk (such as repair, test desk, long distance) which is identified by the code dialed (usually an X11 code).

Special Hunt Test Call: A call made from the test desk to a subscriber line for the purpose of making voltmeter and other tests on the line. Special test calls use a "special" marker, and certain tests which are made on regular calls are omitted.

Tandem Central Office or Tandem Office: A central office used primarily as an intermediate switching point for traffic between other central offices. Unless qualified by a prefix or other explanation, this term is restricted by usage to an office used primarily for the interconnection of local central offices.

Tandem Screening: A circuit feature of combined and completing markers whereby calls incoming to a No. 5 office, serving as a tandem office, from subscribers in a step-by-step office can be screened for rate purposes. The code of the called office received in the marker must be one within the rate area of the calling subscriber in order for the call to proceed through the tandem office, otherwise, the call is denied completion.

Tandem Trunk: A trunk incoming to a tandem office, tandem switchboard, or tandem position from a local office or local switchboard.

Terminal Hunting: The function performed by the switching equipment in a dial office in searching for an idle line in a PBX or other terminal hunting group.

Terminating Stage: The switching process involved in extending the connection from the selected intraoffice trunk to the terminating line. The terminating stage is a subdivision of the marker intraoffice trunk job.

Theoretical Number: An arbitrary designation for the numbers associated with only one of three office codes using the same 10,000 number series. The numbers associated with the other office codes only are designated as physical numbers or extheo numbers.

Toll Call: Any call for a destination outside of the local service area of the calling station.

Tone Trunk: A trunk which supplies tone to the calling subscriber. The marker attempts to route a subscriber to a tone trunk for conditions of overflow, partial dial, vacant code, or line busy on an intraoffice call.

Trunk Link: A switching arrangement for connecting originating registers and trunks to junctors.

TX Call: A call which terminates at a TX operator's position.

TX Operator: An outward toll operator or team of operators who performs three specialized jobs:

- (a) Initiates subsequent attempts on toll calls which are delayed because either (1) the called party does not answer, (2) the called line is busy, (3) an "all circuits busy" condition was encountered on the initial attempts by the CLR operator, or (4) the specific person was not available on a person-to-person call. In the last case the CLR operator "leaves word" for the called person to call the TX operator in the originating city.

(b) Completes the call when the specific person in the distant city reports back on a "leave word" call.

(c) Keeps a file of uncompleted and delayed toll tickets to specific locations and answers queries concerning the status of completion.

TX Trunk: A trunk that has its terminating end in front of a TX operator.

Unassigned Number: A number within the assigned capacity for a particular office but unassigned to a subscriber.

Vacant Code or Vacant Code Point: A code point which is unassigned. If a call is directed to a vacant code point, it is routed to an operator or vacant code trunk.

Vertical File: The ten vertical units of a crossbar switch located one above another on a line link frame or on a split line link frame. A vertical file is five switches high on the left and five high on the right.

Vertical Group: The five vertical files making up the left or right half of a column of lines.

Note: One of the vertical groups of each line link frame contains the no-test file. Consequently this vertical group has only forty instead of fifty lines.

Attached:

Figs. 1, 2, 4 to 6, 8 to 31, 37 to 43,
and 47 to 61

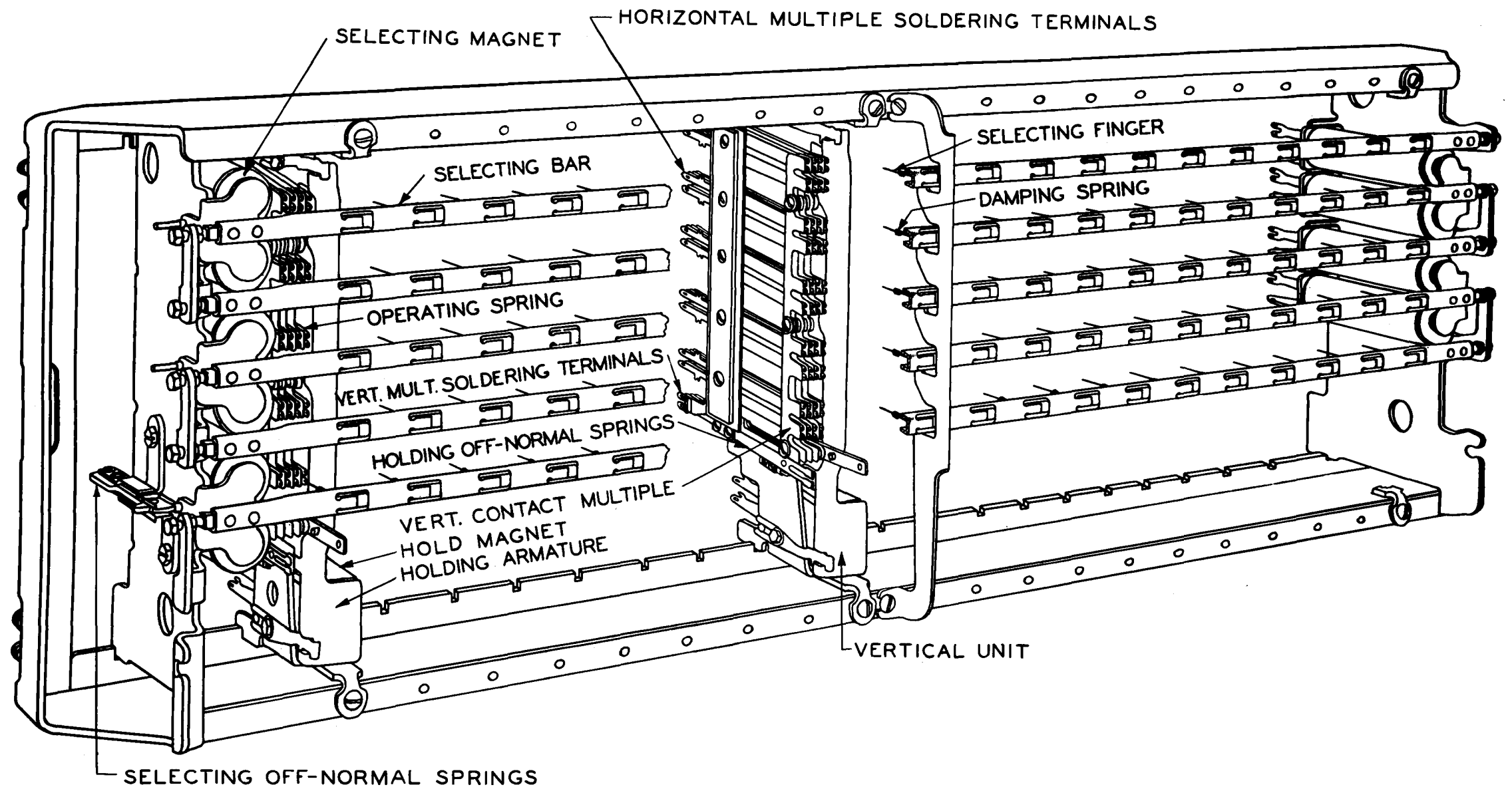


FIG. 1

PARTIAL PERSPECTIVE VIEW OF 20-VERTICAL UNIT CROSSBAR SWITCH (200 POINT)

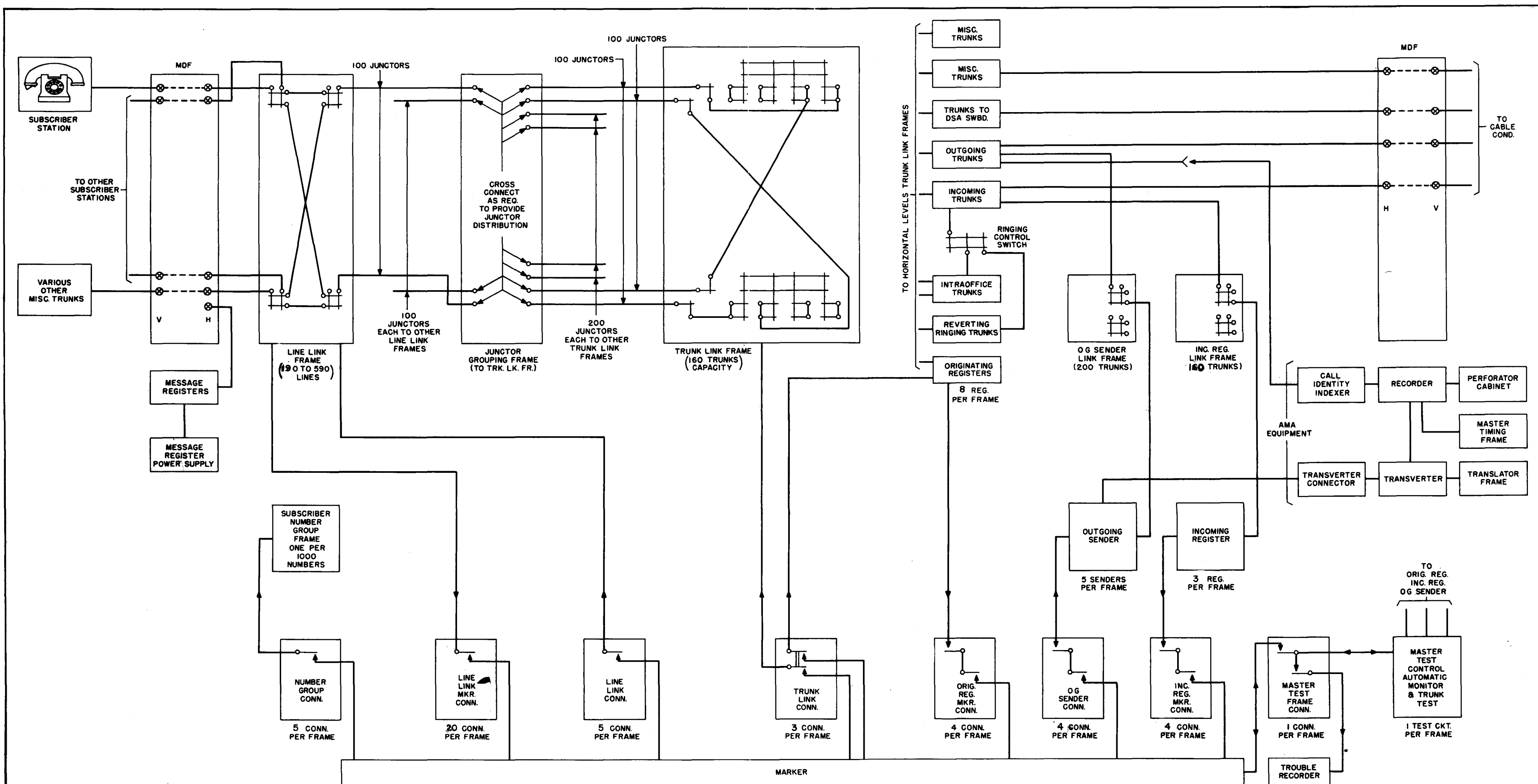


FIG 2
EQUIPMENT SCHEMATIC OF A NO. 5 CROSSBAR OFFICE

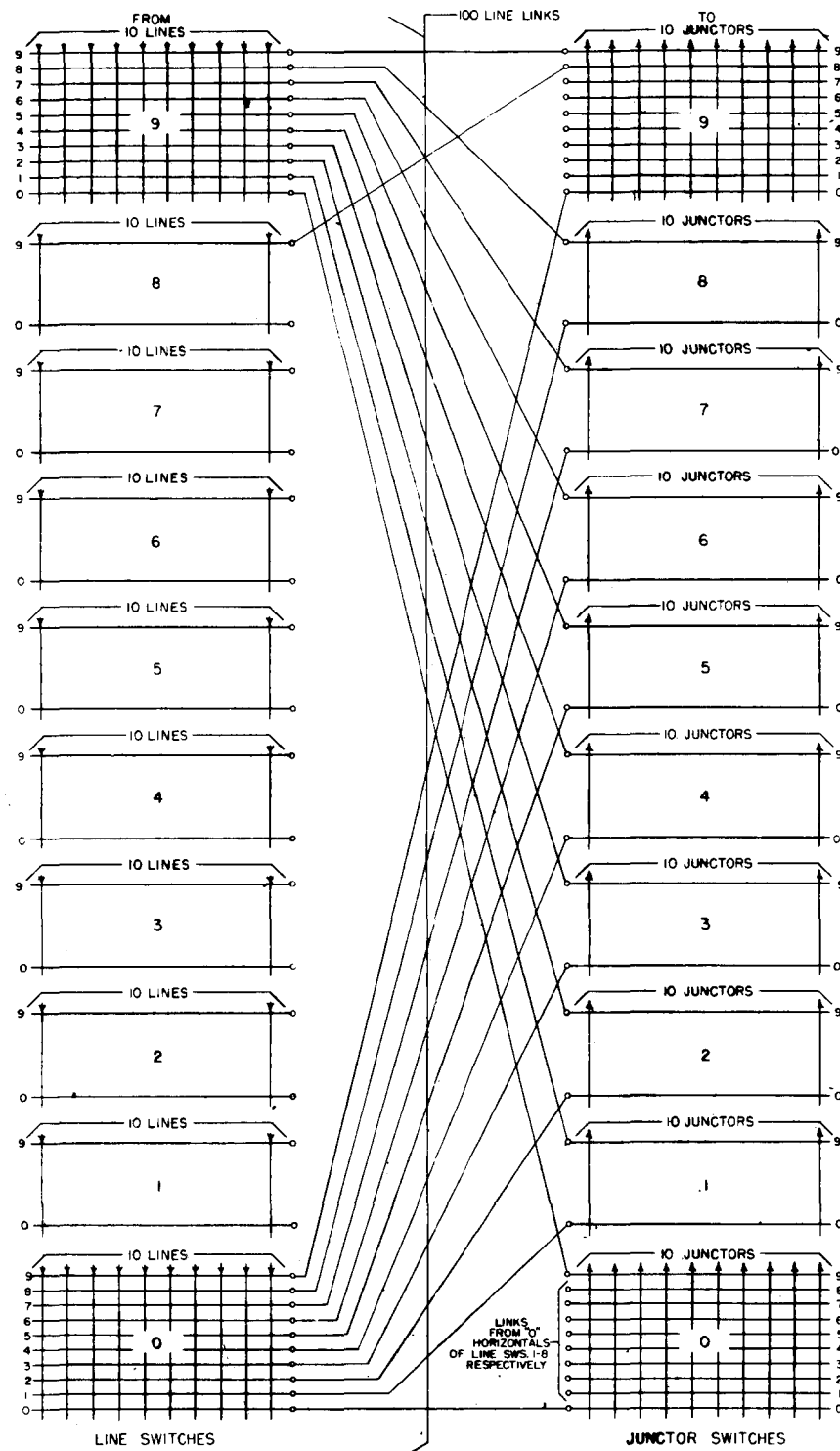


FIG. 4
LINE LINK DISTRIBUTION

(NO. 5 CROSSBAR)

FIG. 4

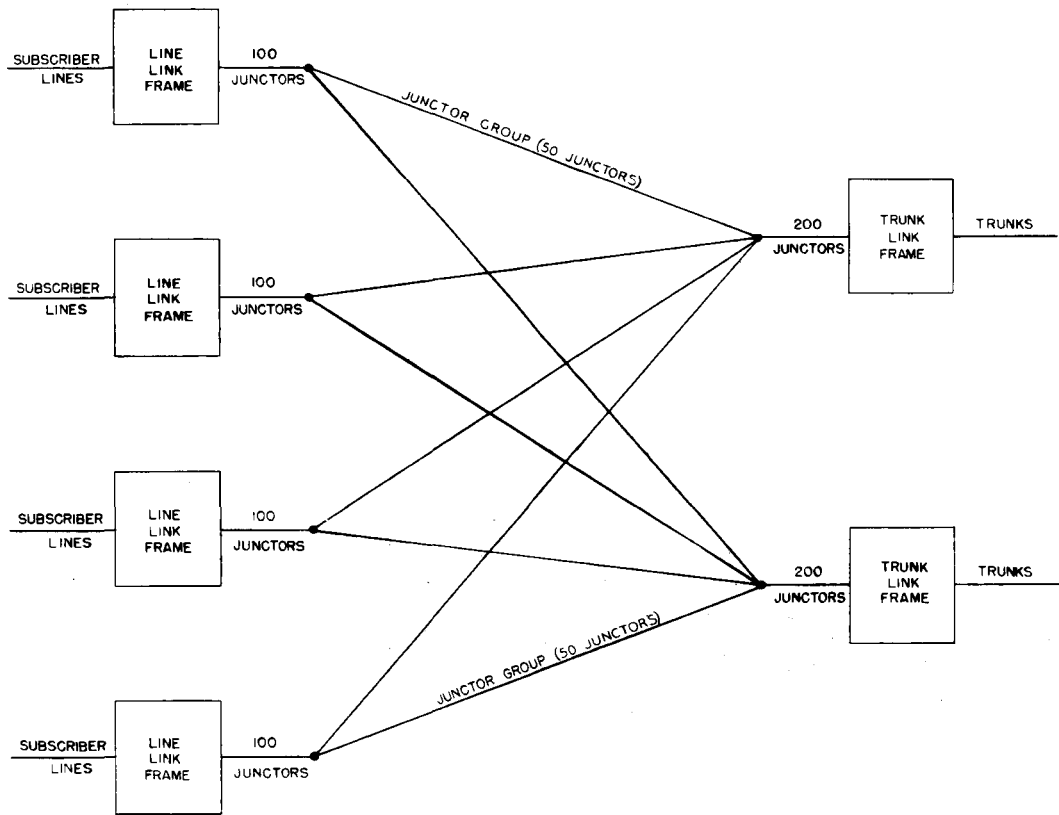


FIG. 5
JUNCTOR DISTRIBUTION
(4 LINE LINK AND 2 TRUNK LINK FRAMES)

(NO.5 CROSSBAR) FIG. 5

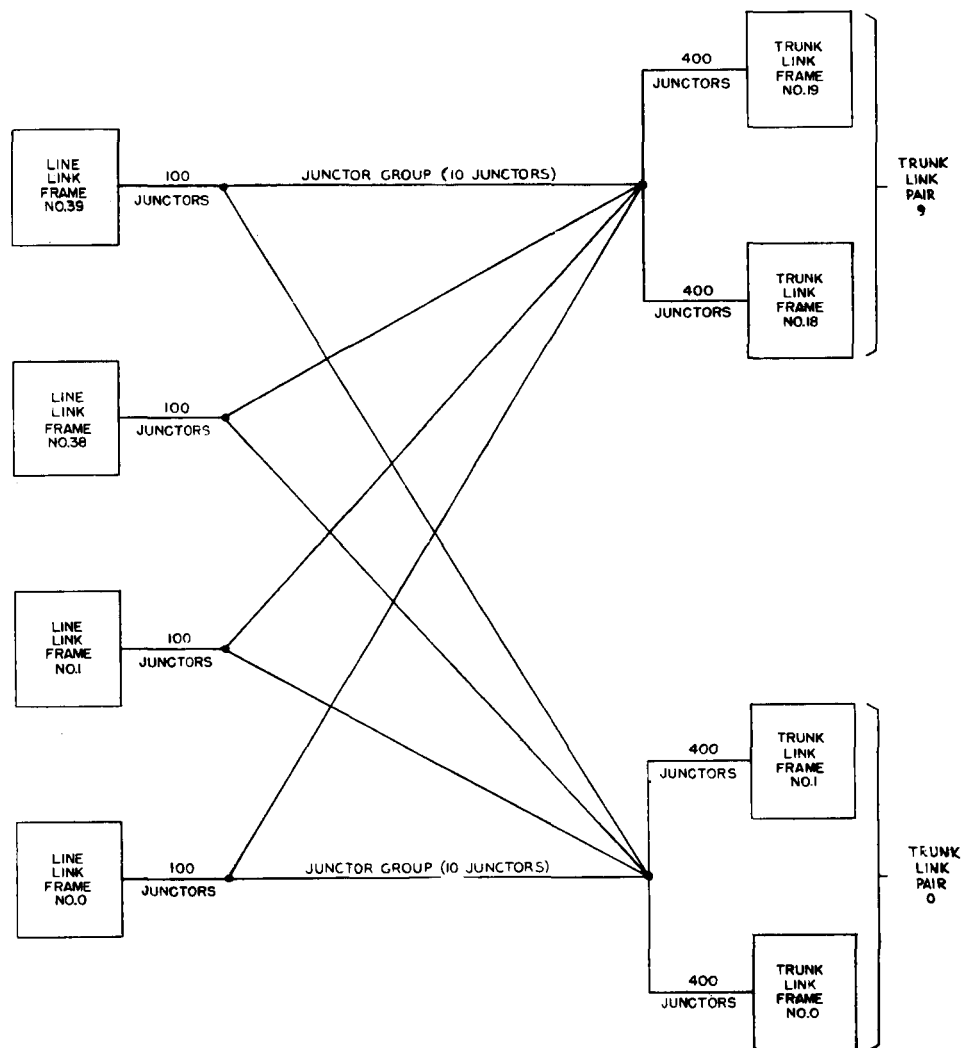


FIG. 6
PAIRING OF TRUNK LINK FRAMES
(40 LINE LINK AND 20 TRUNK LINK FRAMES)
INITIAL INSTALLATION

(NO.5 CROSSBAR) FIG. 6

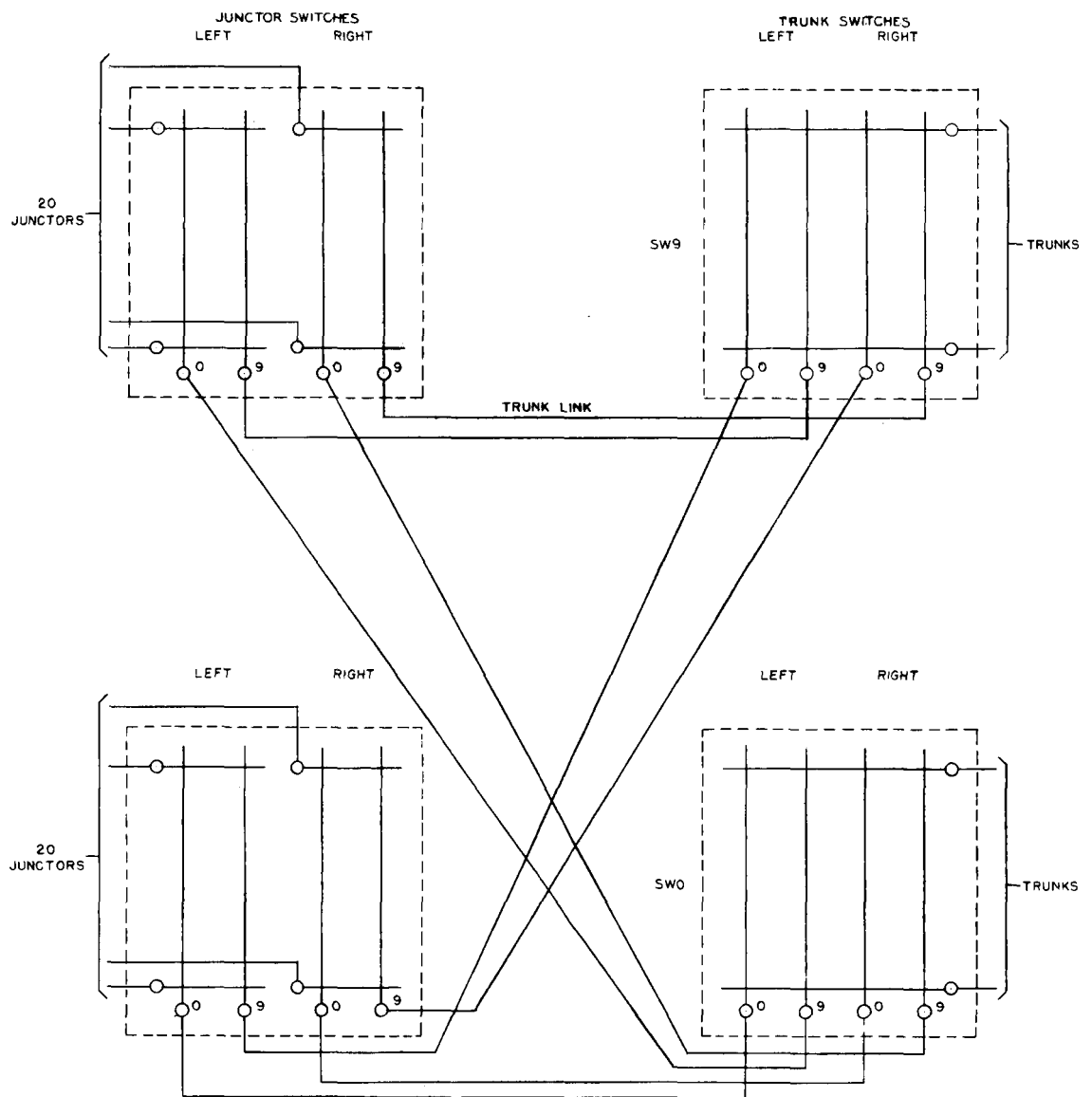


FIG. 8
TRUNK LINK DISTRIBUTION

(NO. 5 CROSSBAR) FIG. 8

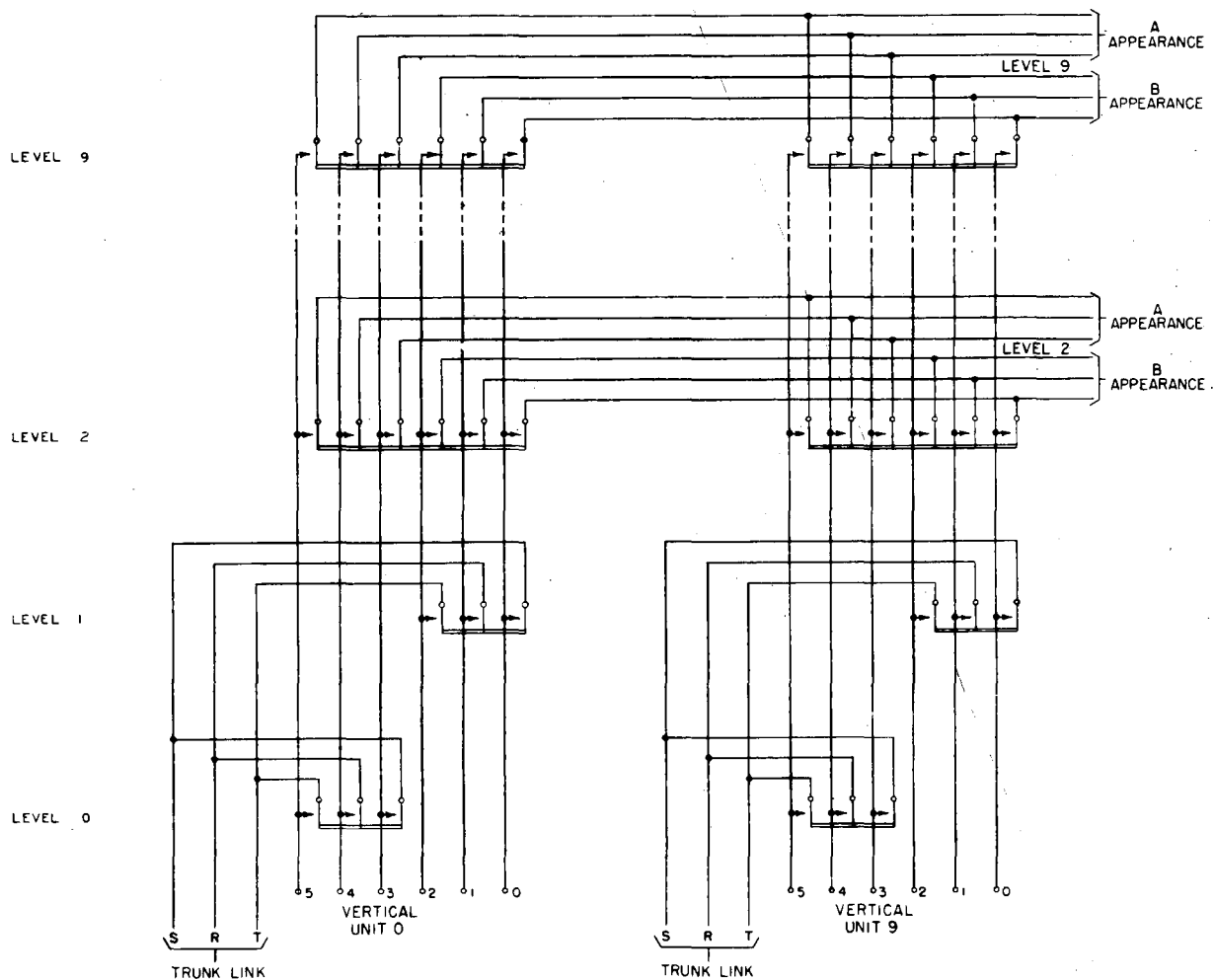
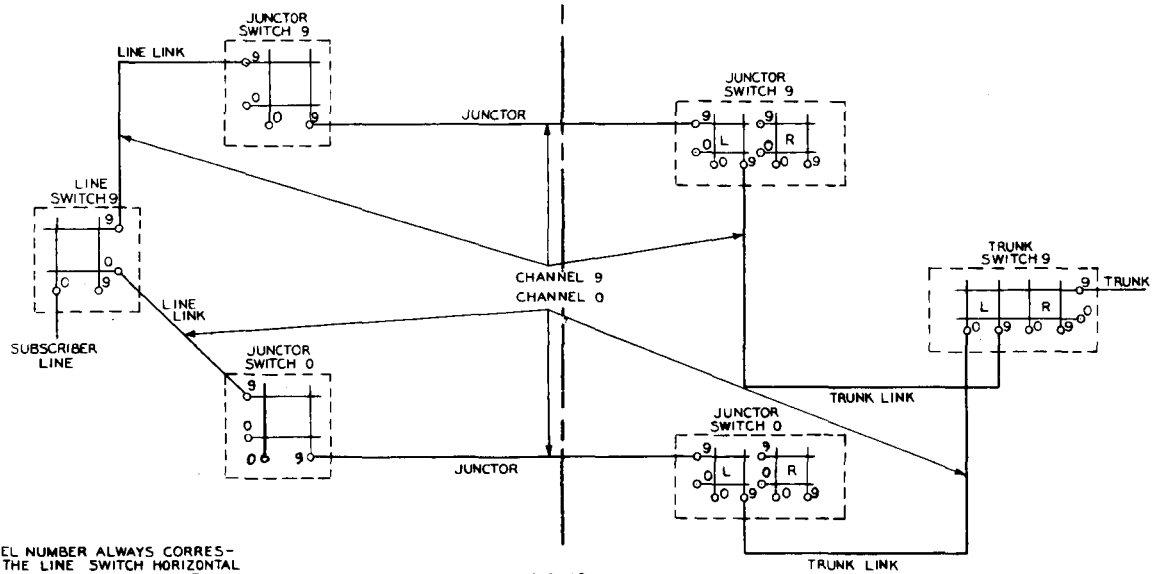


FIG. 9
SWITCH ARRANGED FOR 16 TRUNK APPEARANCES ON TRUNK LINK FRAME

(NO. 5 CROSSBAR) FIG. 9

LINE LINK FRAME 18

TRUNK LINK FRAME 09



NOTE:
THE CHANNEL NUMBER ALWAYS CORRESPONDS TO THE LINE SWITCH HORIZONTAL NUMBER OF THE LINE LINK, THE TRUNK SWITCH VERTICAL NUMBER OF THE TRUNK LINK, AND THE JUNCTION SWITCH NUMBER. ALL OTHER ELEMENTS ARE NUMBERED INDEPENDENTLY OF CHANNEL NUMBER CONSIDERATIONS

FIG. 10A
CHANNELS FOR 20 LINE LINK-10 TRUNK LINK FRAMES

LINE LINK FRAME 00

TRUNK LINK FRAME 00

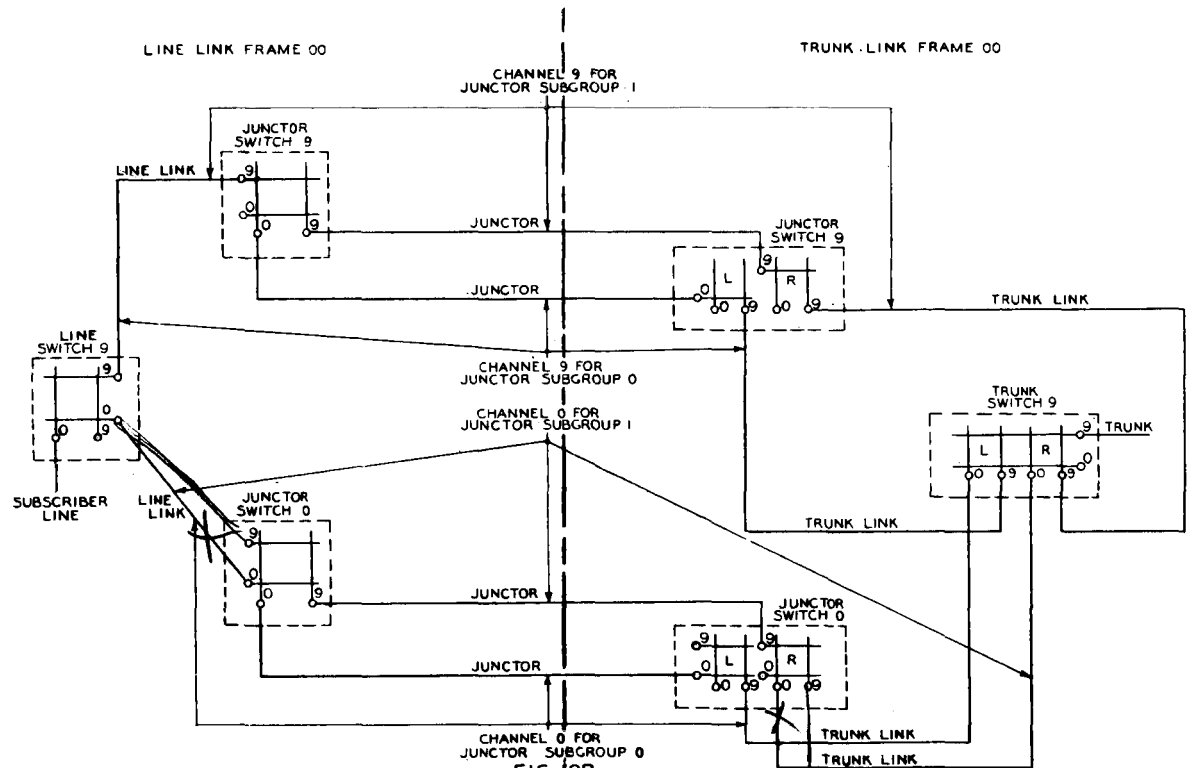
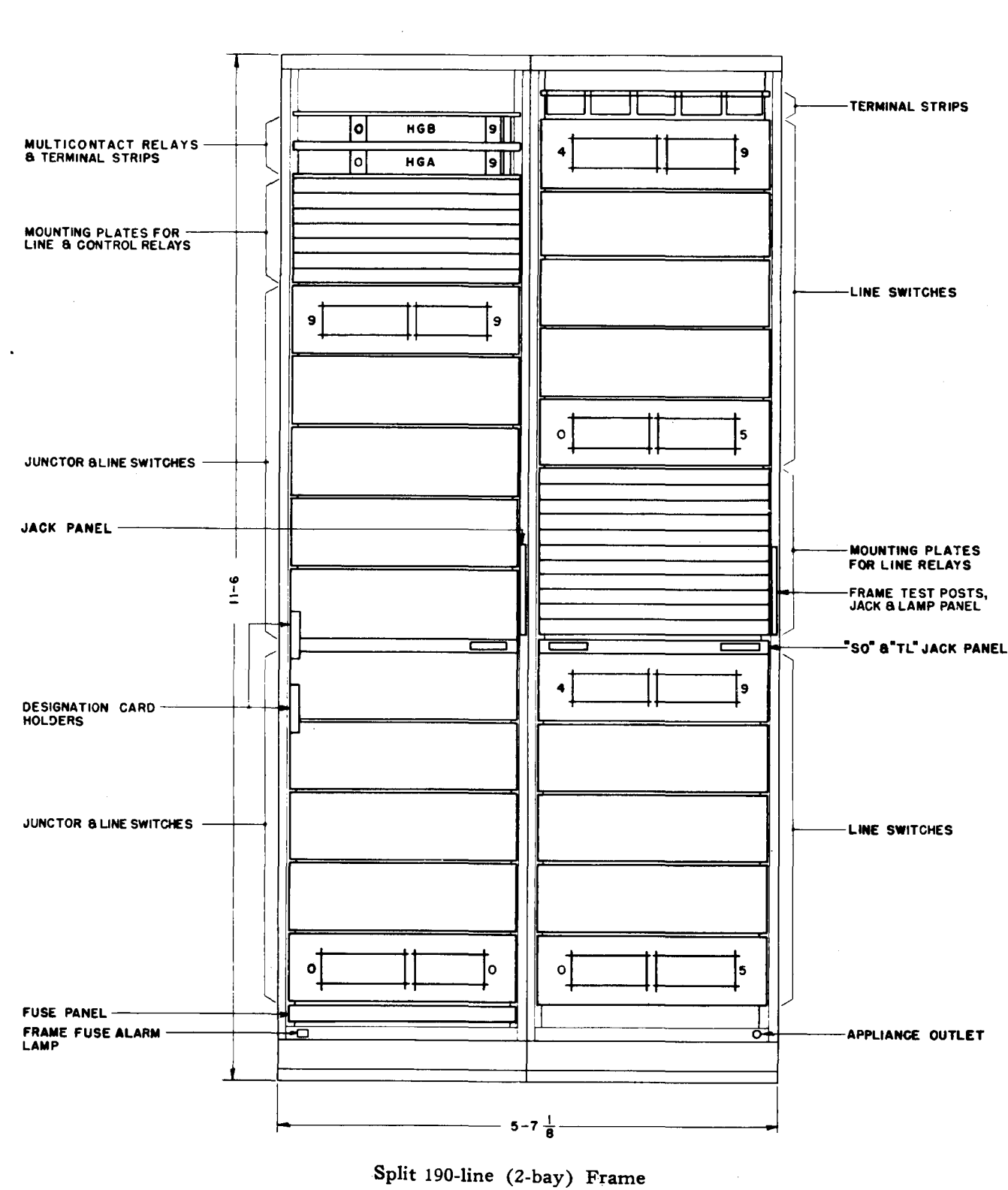
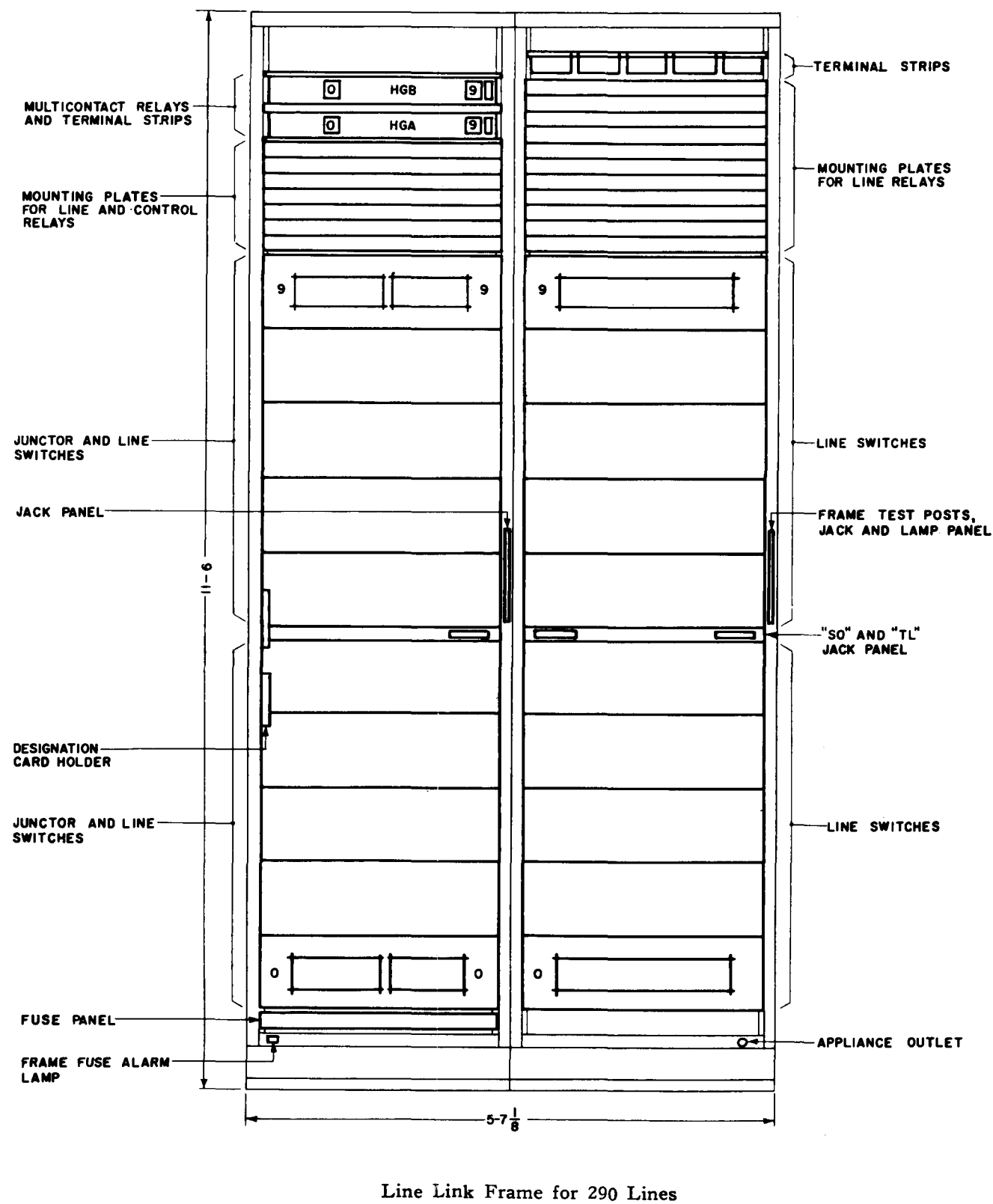


FIG. 10B
CHANNELS FOR 10 LINE LINK-5 TRUNK LINK FRAMES

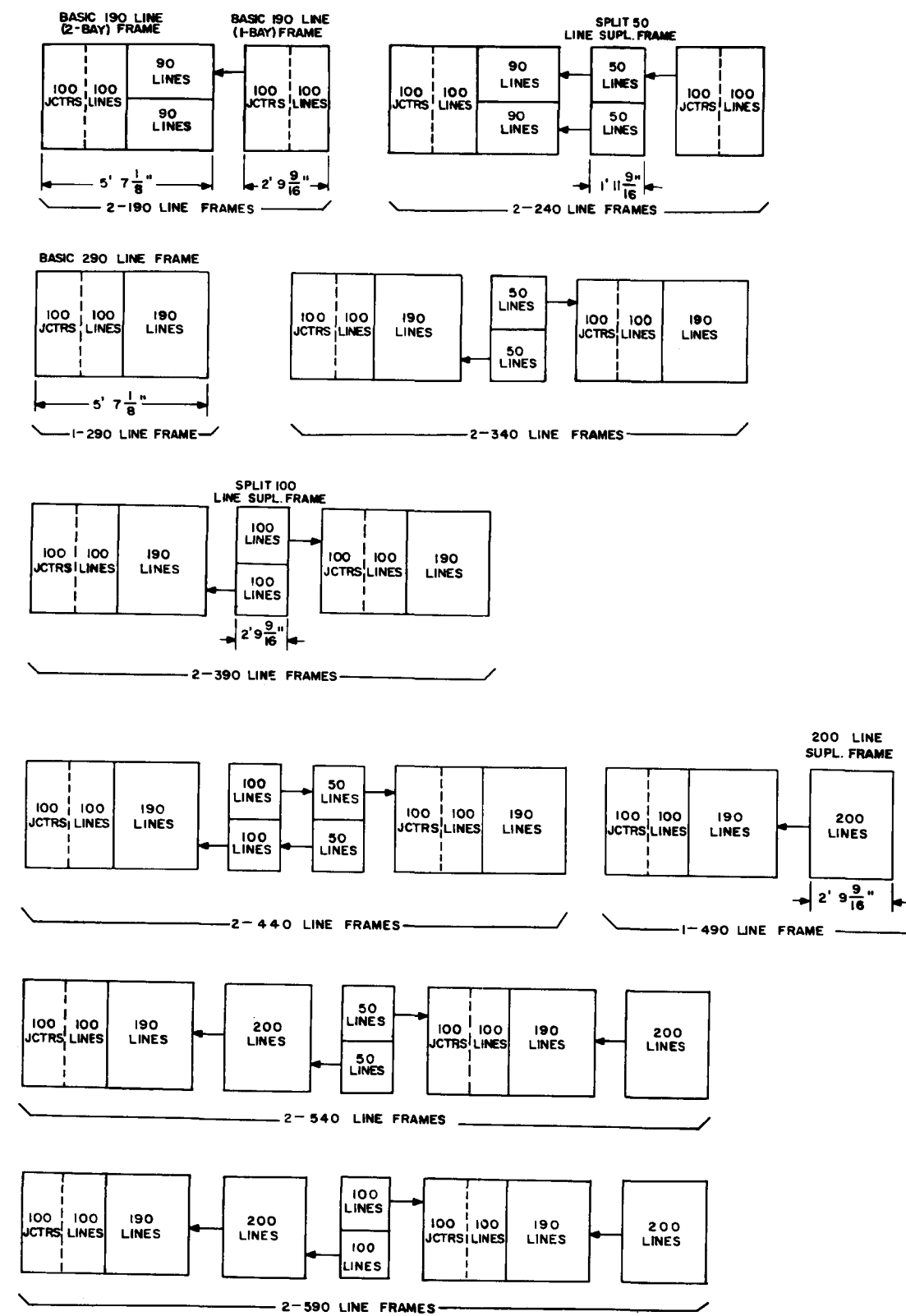
(NO. 5 CROSSBAR) FIG. 10 A,B



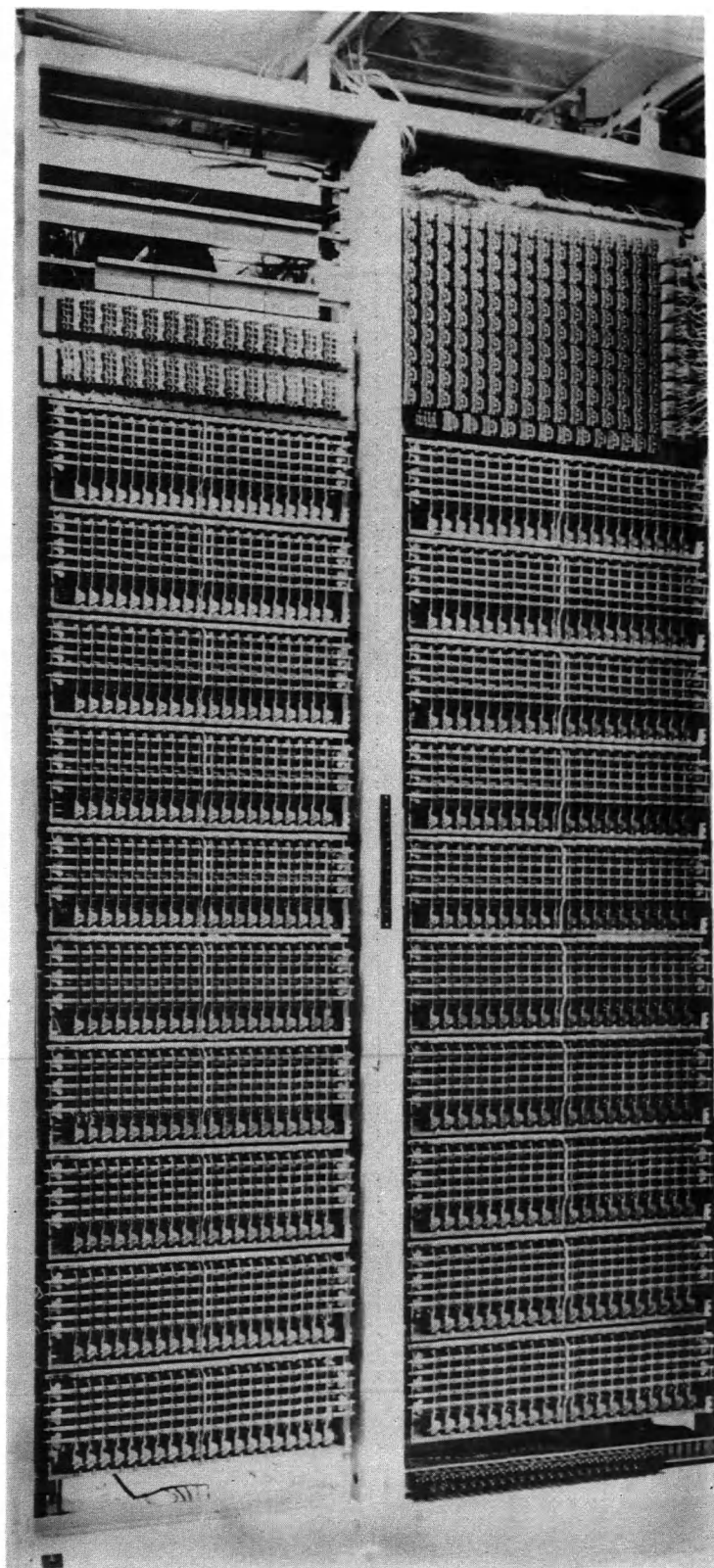
Split 190-line (2-bay) Frame



Line Link Frame for 290 Lines



Association Of Line Link Basic and Supplementary Frames for 50-line Increments



TRUNK LINK FRAME

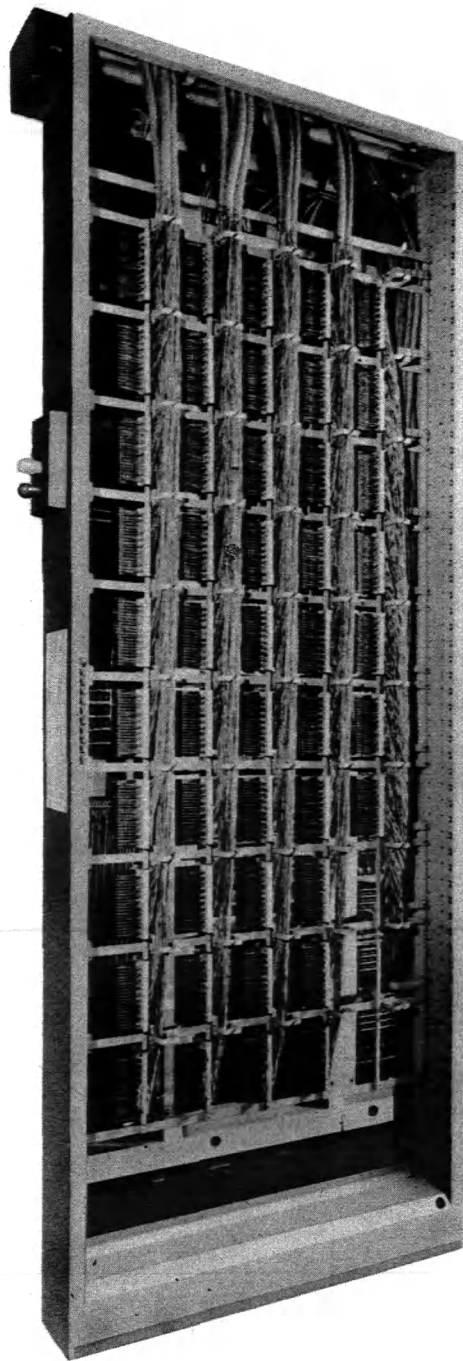
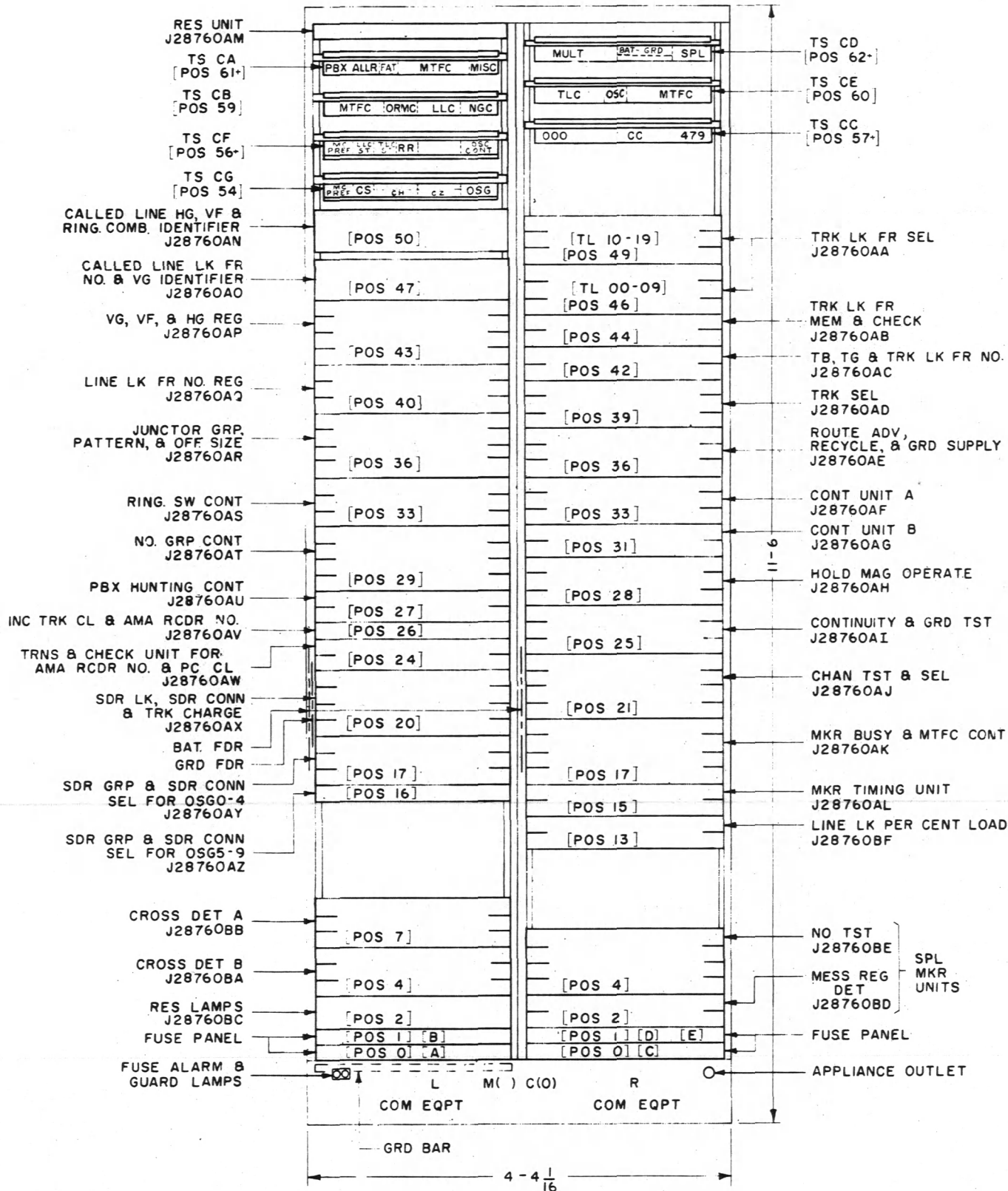


FIG.13 - JUNCTOR GROUPING FRAME



MARKER FRAME
COMMON EQUIPMENT FRAME
COMPLETING MARKER

TRK GRP & SDR GRP ALLOTTER
J28760CG
CLASS OF CALL
J28760CA
TDM TRK CL SCREENING
J28760CS
SUB CL OF SERVICE B
J28760CC
SUB CL OF SERVICE A
J28760CB
SERVICE TREATMENT REL
J28760CD

TS TO
[POS 62+]
TS TP
[POS 60]
TS TQ
[POS 57+]

TS TC
[POS 40+]
TS TD
[POS 37+]

TS TE
[POS 36]
TS TF
[POS 32+]

TS TG
[POS 31]

TS TH
[POS 26]

TS TJ
[POS 22]

TS TK
[POS 20]

TS TL
[POS 16+]

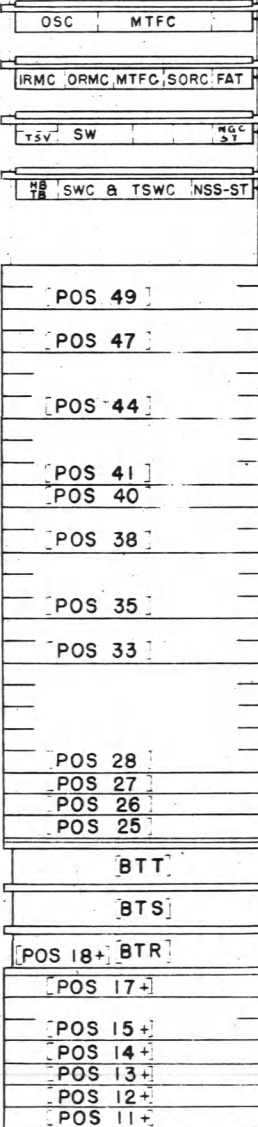
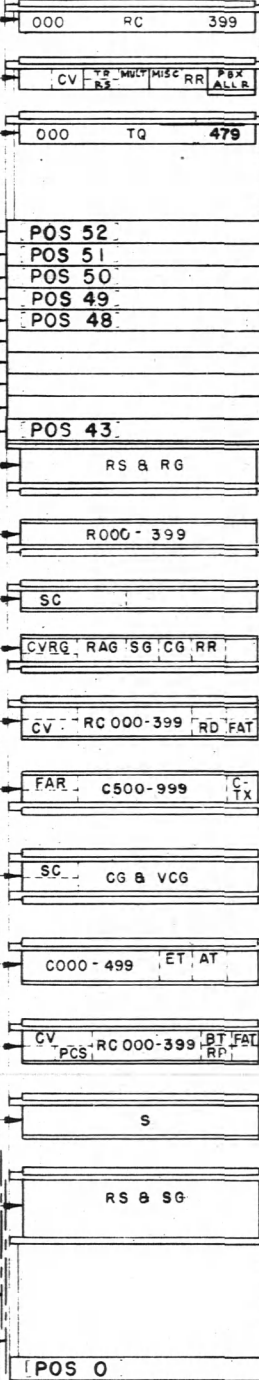
TS TM
[POS 13]

TS TN
[POS 6+]

BAT. FDR

GRD FDR

GRD BAR

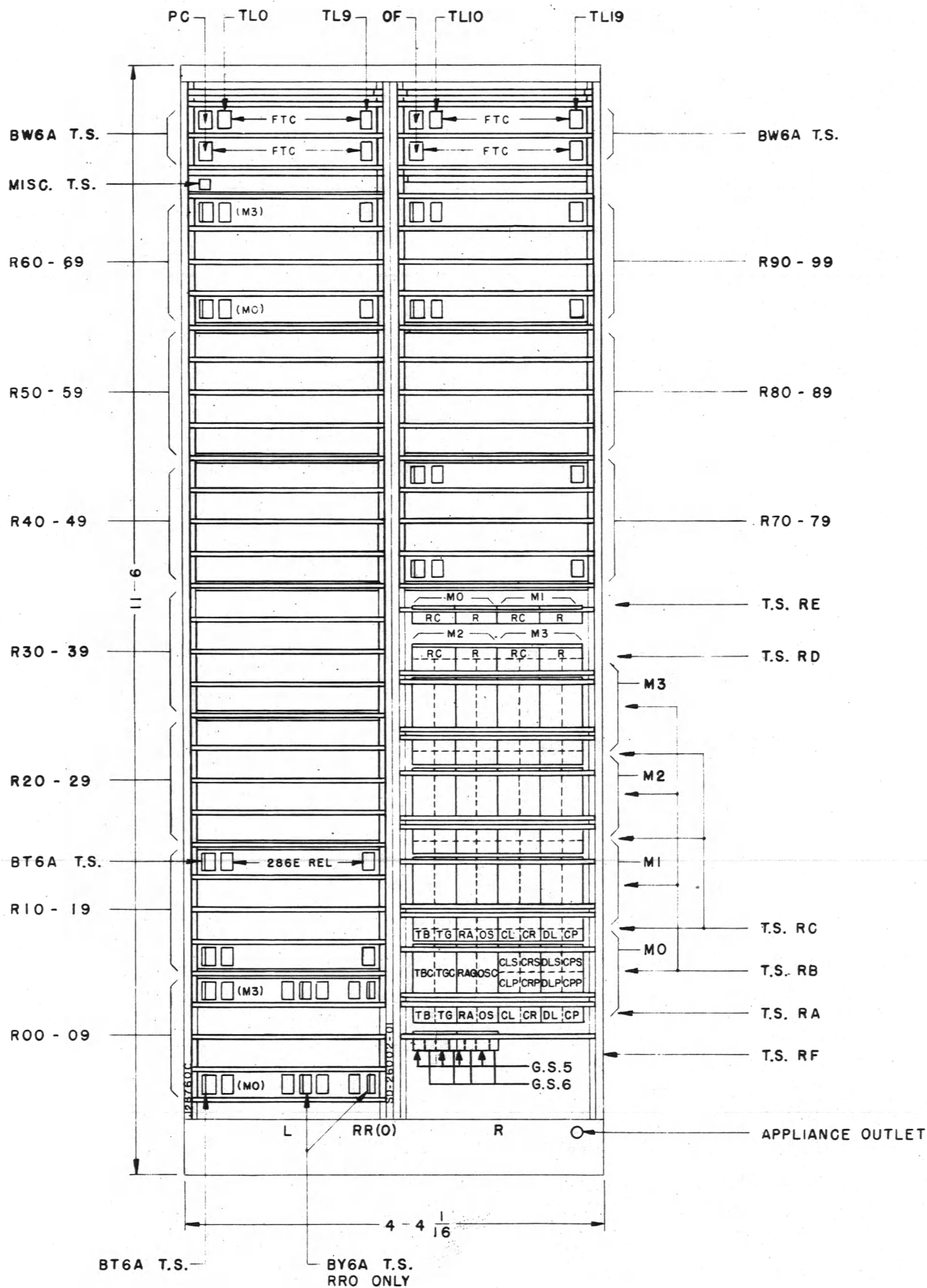


TS TR
[POS 62+]
TS TS
[POS 60]
TS TA
[POS 57+]
TS TB
[POS 55]

TRANSFER & CHECK FOR
CODE PAT. TO SDR
J28760CH
ROUTE SERIES FOR
MESSAGE BILLING
J28760CI
TRANSFER & CHECK FOR CL,
CR & DL TO SDR
J28760CV
ROUTE SERIES & ROUTE
TRANSFER
J28760CJ
PARTIAL DIAL & COIN CONT
J28760CK
LOC COMPL CONTROL
J28760CL
CALLED LINE UNITS REG &
PBX SLEEVE TEST
J28760CU
CALLED LINE TH, H & T REG
J28760CT
TRANSFER & CHECK FOR
DIALED DIG. A-L
J28760CM
TRANSLATOR CONN. FOR
B & C DIGITS
J28760CN
TRANSLATOR CONTROL
J28760CO
LOCAL 2 DIGIT TRANSLATOR
J28760CQ
3 DIGIT TRANSLATOR
3 DIGIT TRANSLATOR FOR XO
J28760CP
TX CODE TRANSLATOR
J28760CE
EXTRA 2 DIGIT TRANSLATOR
J28760CR
PEG COUNT PRE-ROUTE
J28760CF
INDIVIDUAL PEG COUNT FOR
LARGE TRK GRPS
J28760CW

APPLIANCE OUTLET

MARKER FRAME
TRANSLATOR AND CODE TREATMENT FRAME



MARKER FRAME
ROUTE RELAY FRAMES

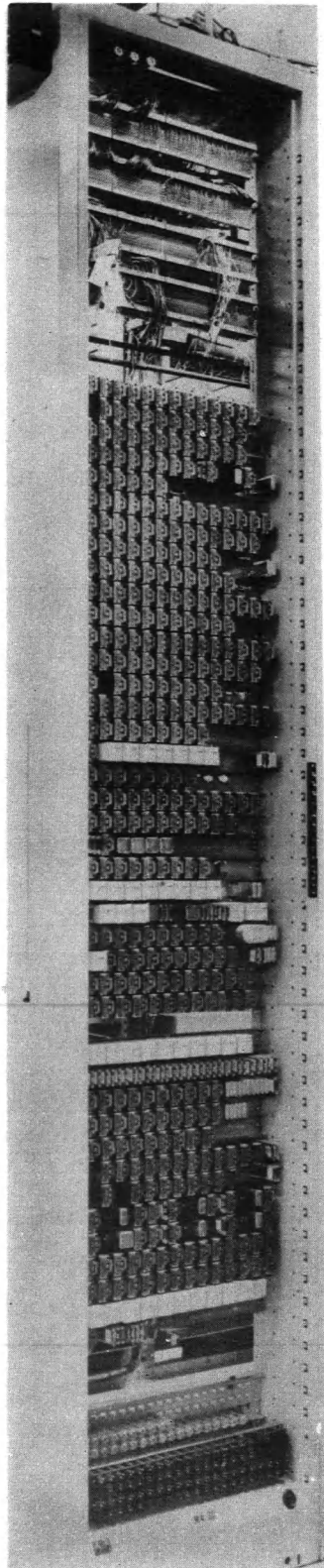
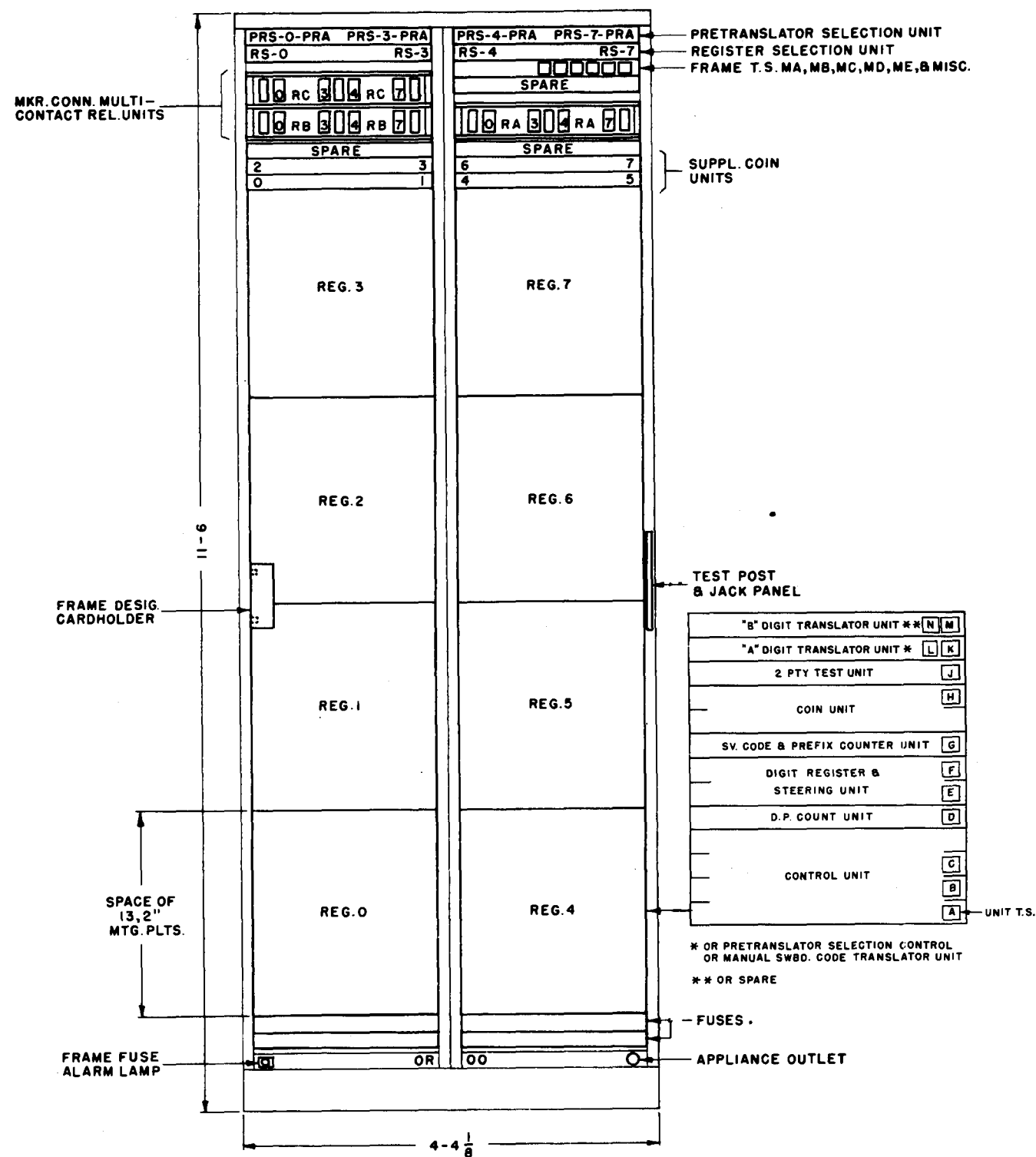


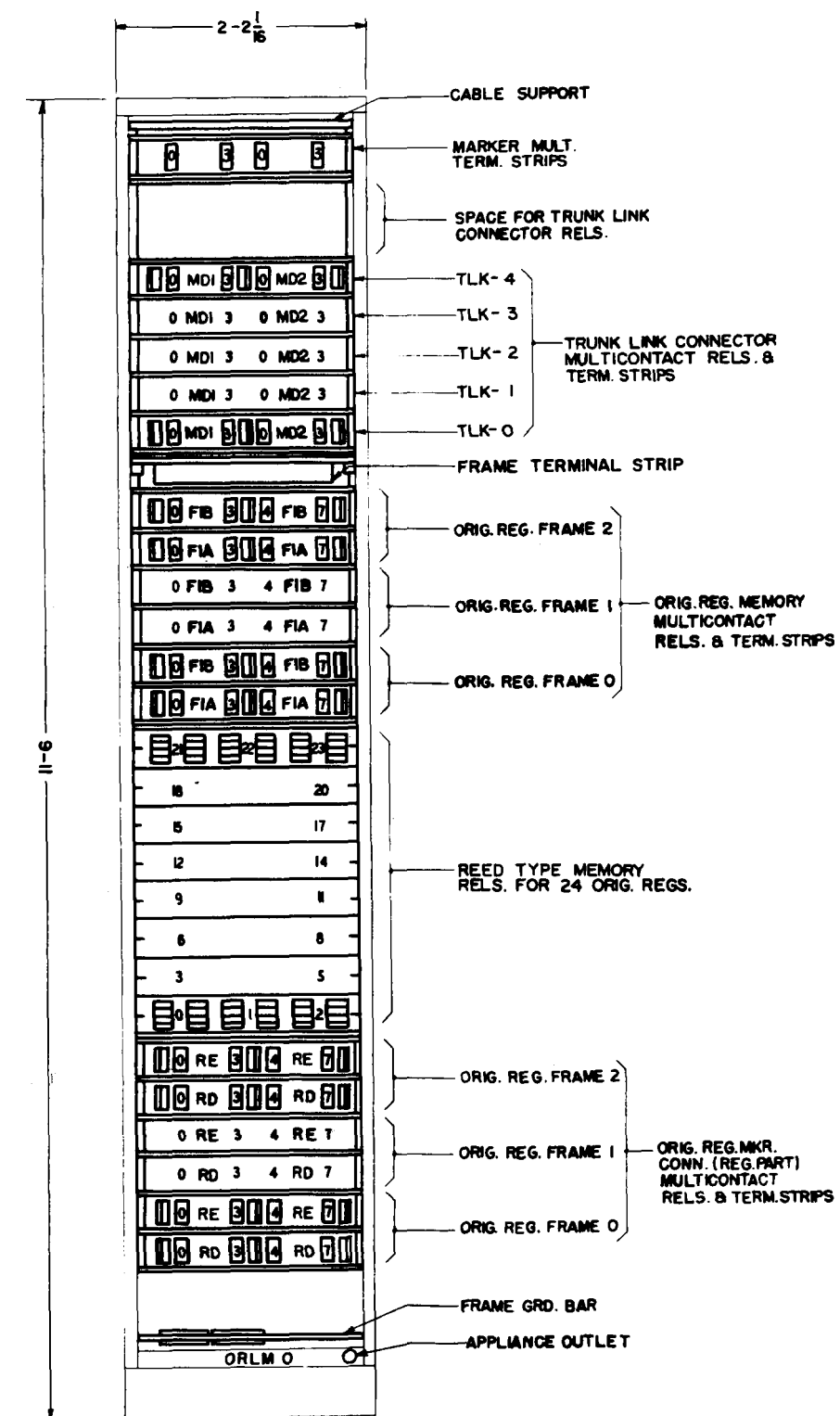
Fig. 17—Dial Tone Marker

NO PICTURE OR SKETCH AVAILABLE
AT TIME OF PRINTING

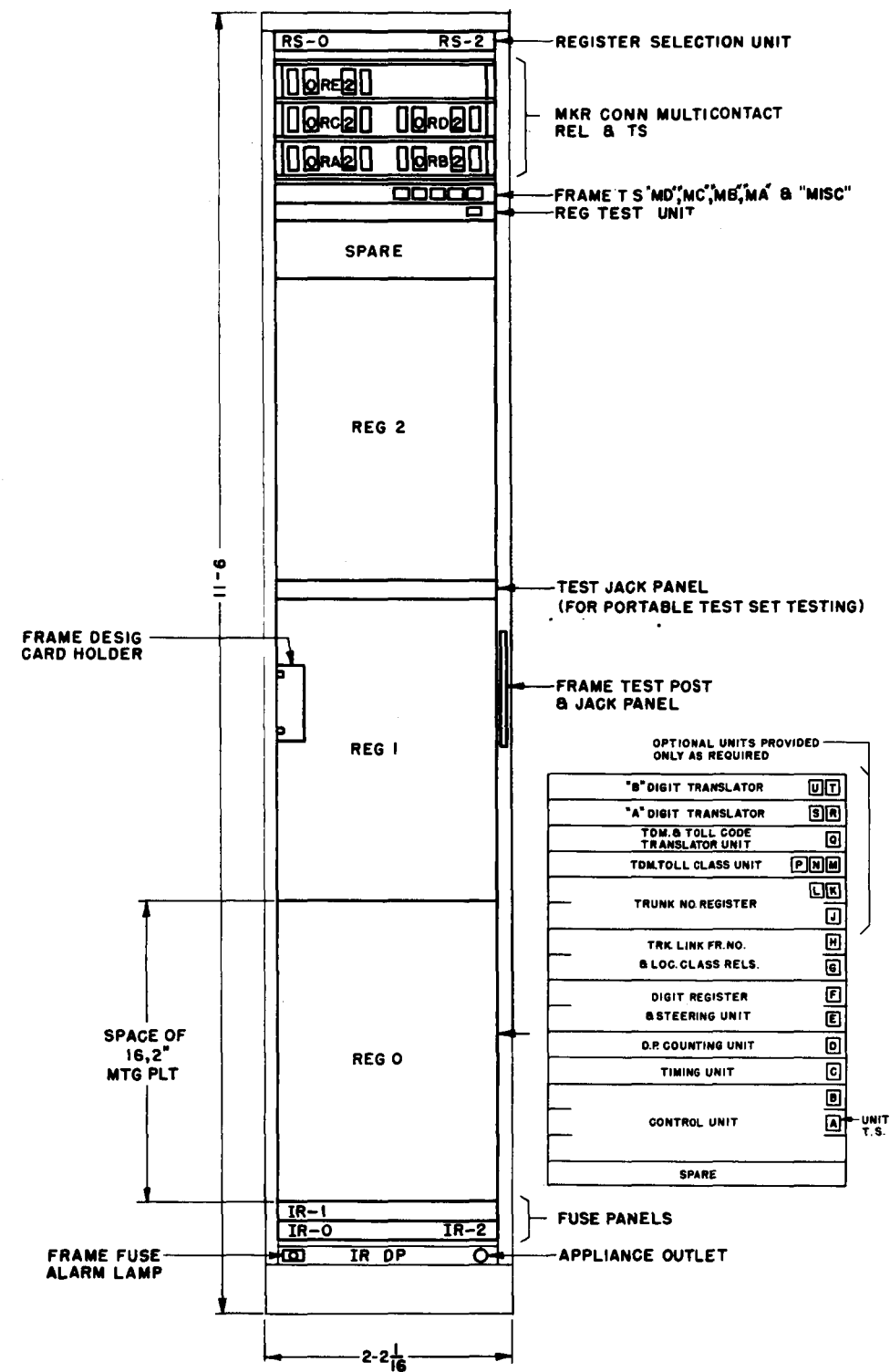
MARKER FRAME
PBX ALLOTTER FRAME



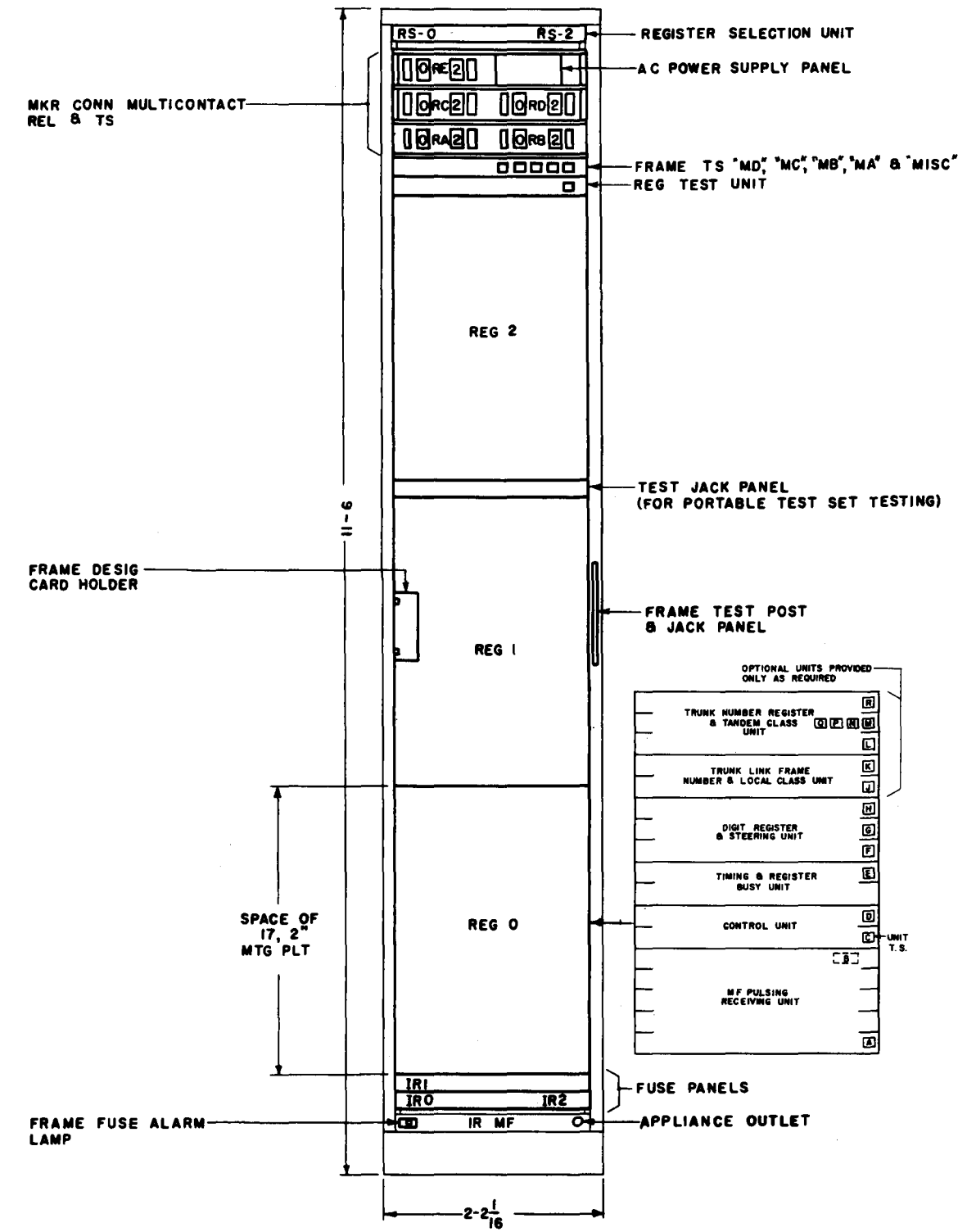
Originating Register Frame



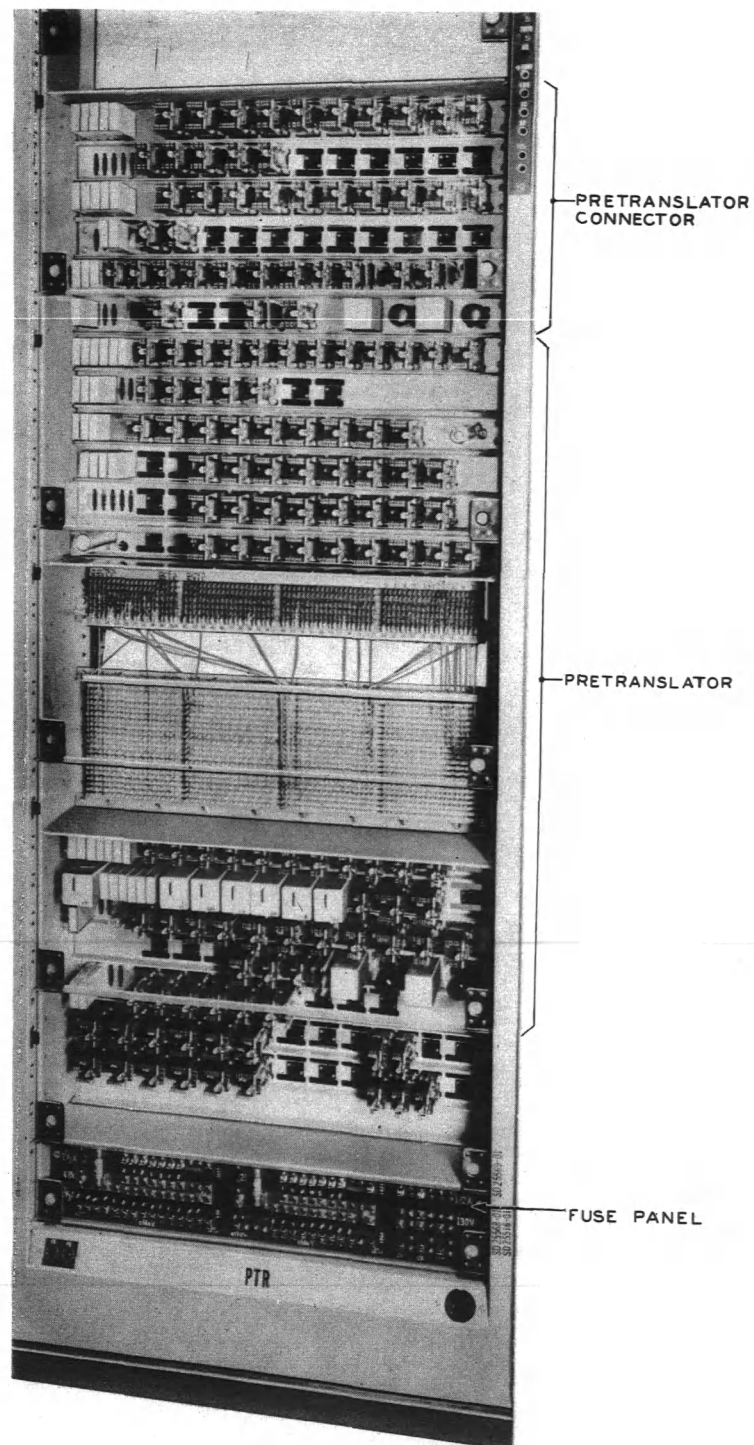
Originating Register Line Memory Frame



For Dial Pulse Incoming Registers



For Multifrequency Incoming Registers



Pretranslator Frame

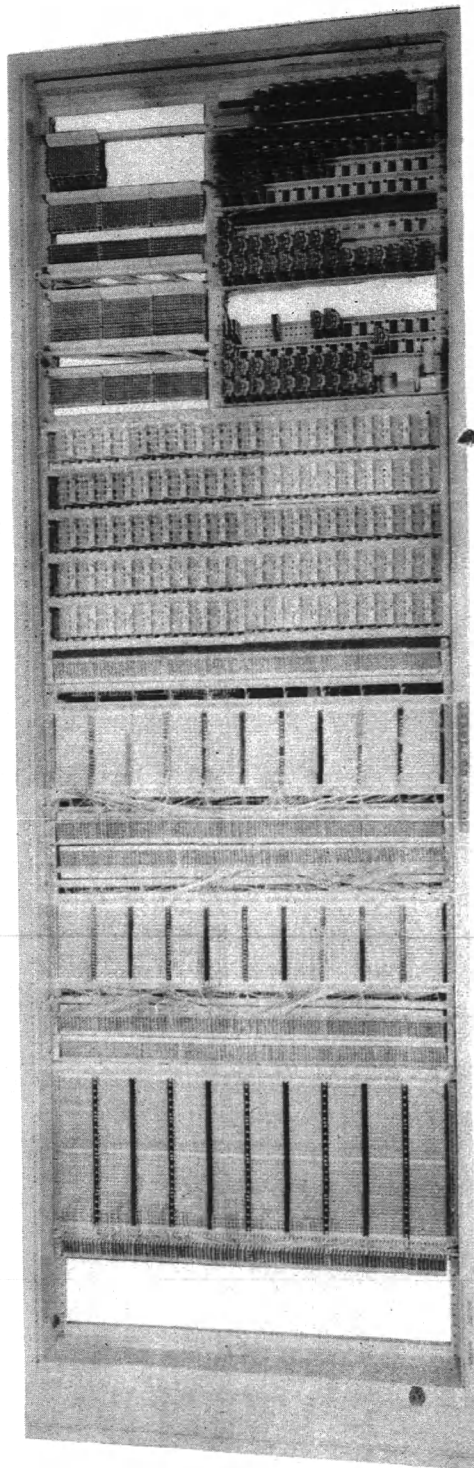
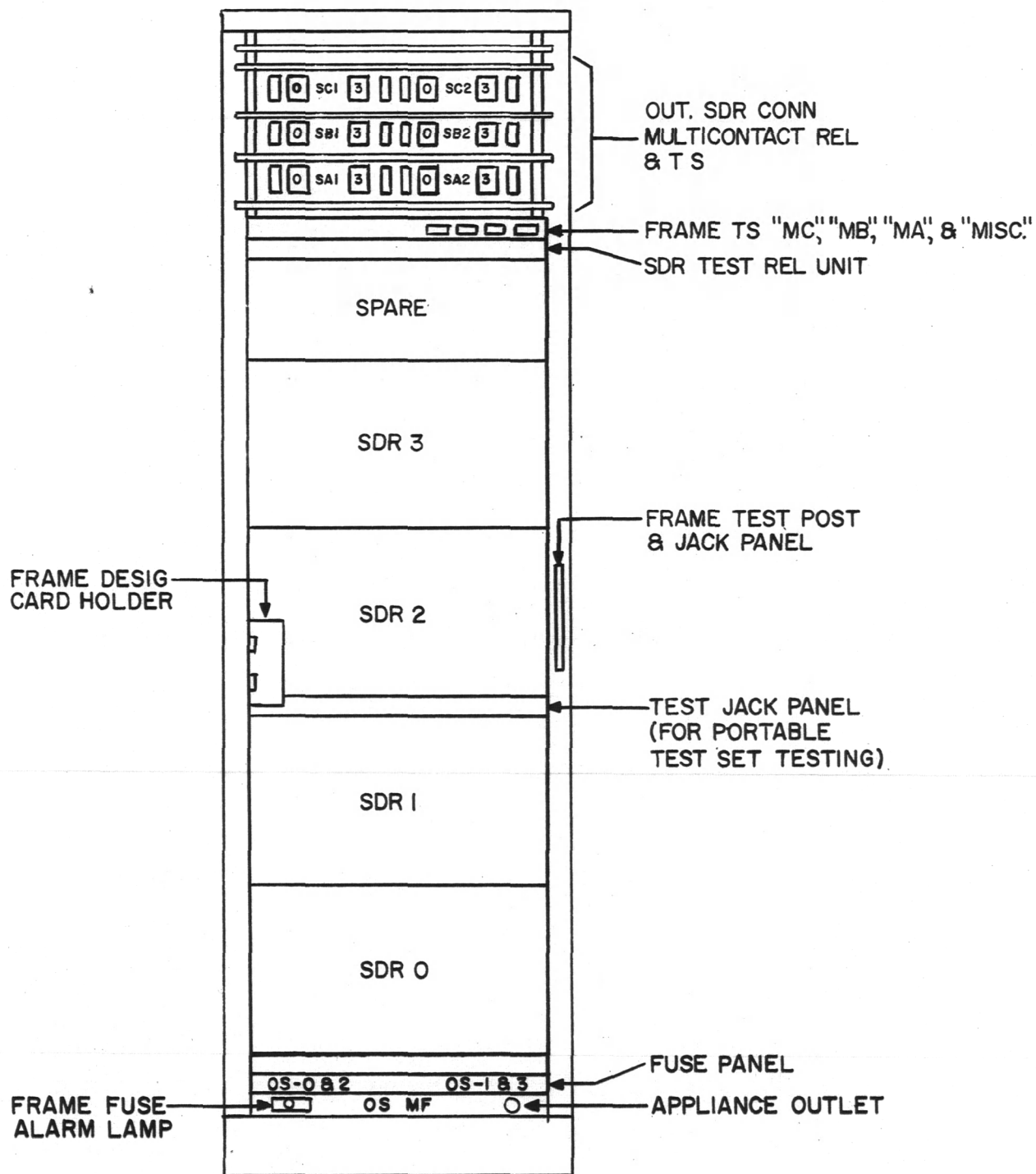
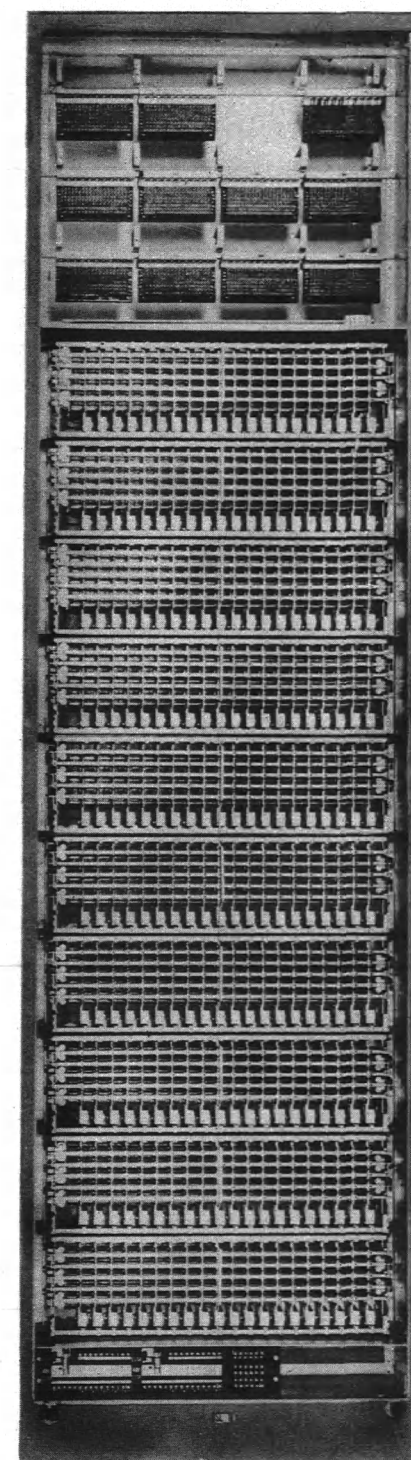


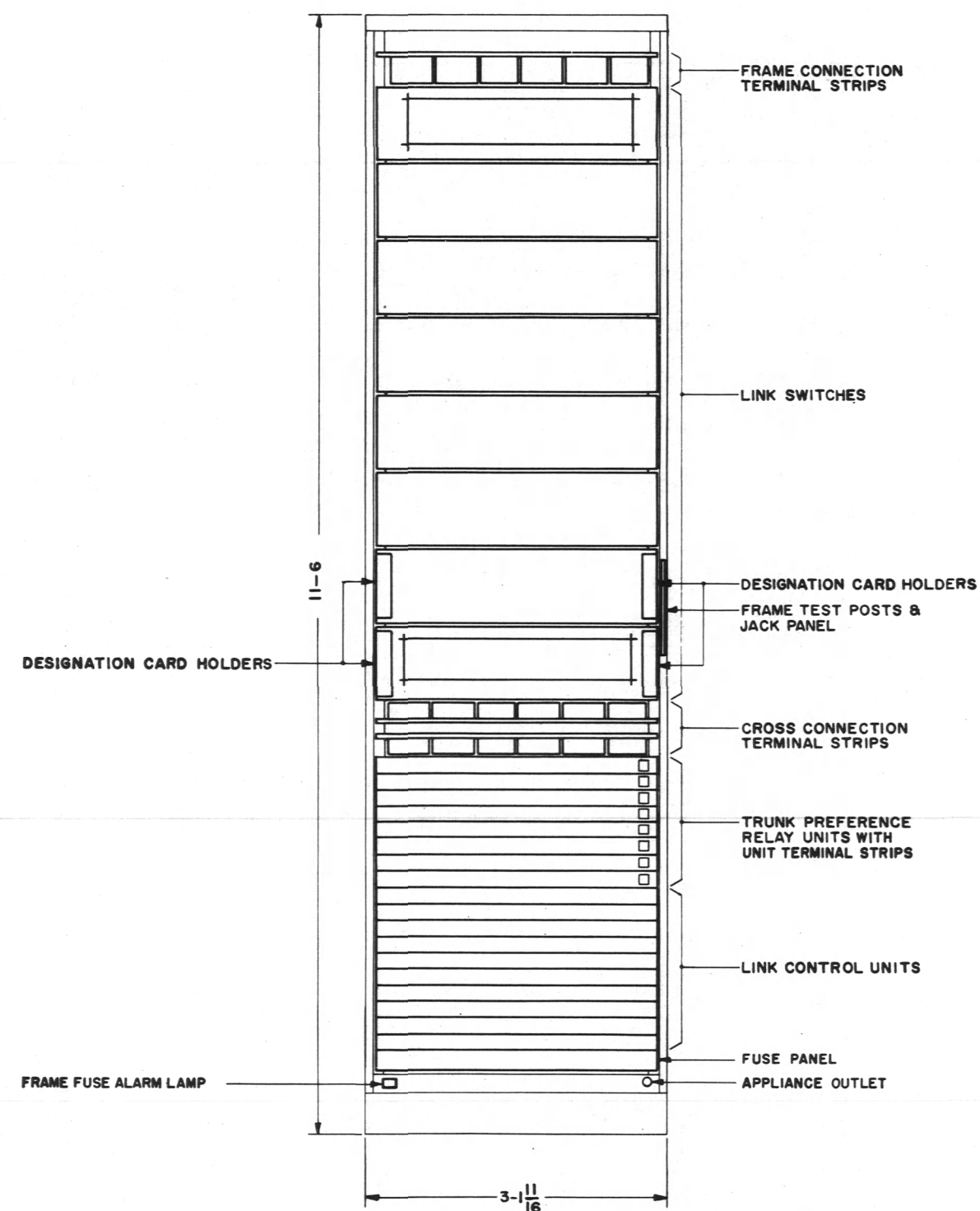
FIG. 22
NUMBER GROUP FRAME



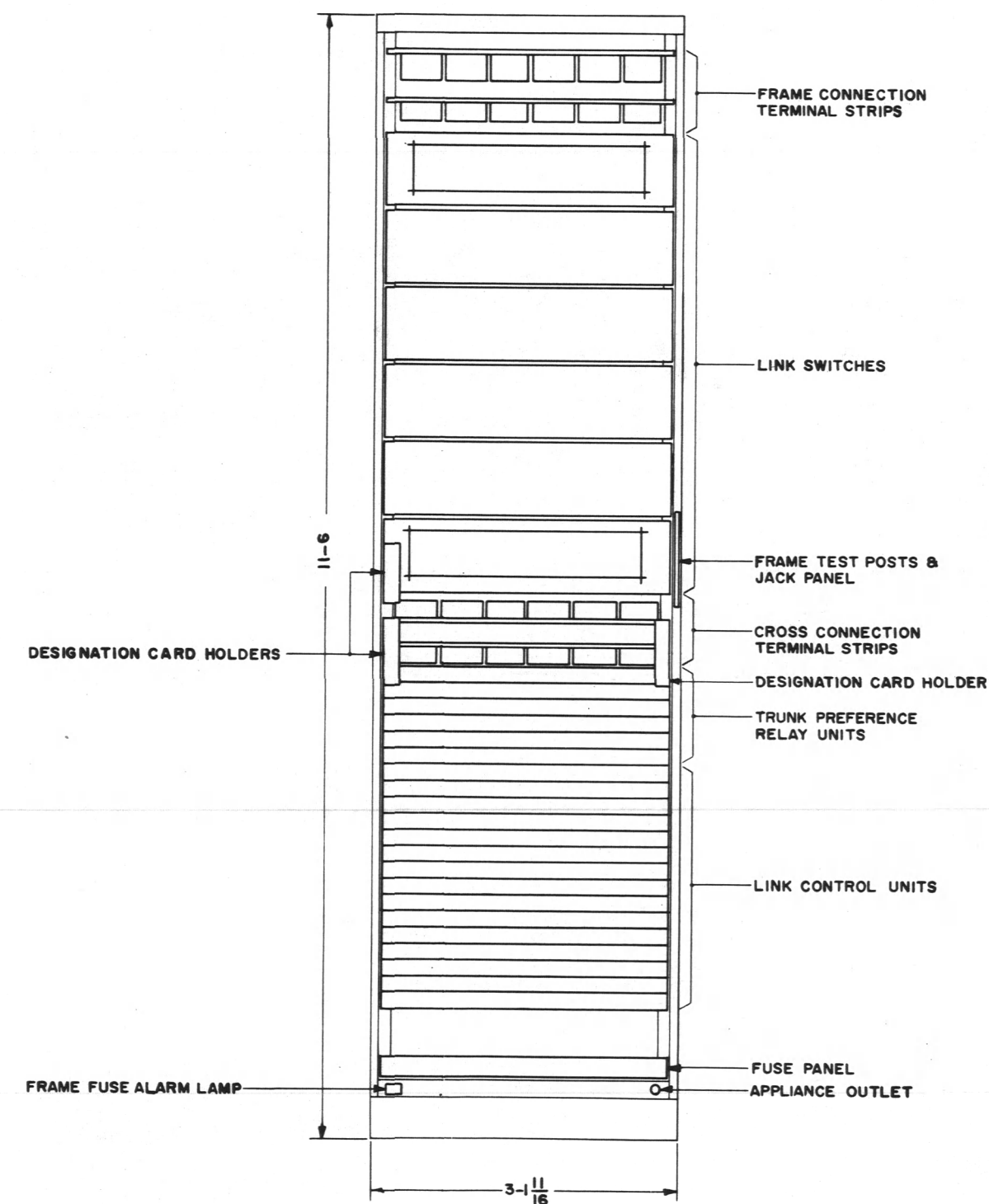
OUTGOING SENDER FRAME



Outgoing Sender Link Frame



With Wire-spring Relays for Non-Bylink Operation



With Wire-spring Relays for Bylink Operation

FIG. 24
REGISTER AND SENDER LINK FRAMES

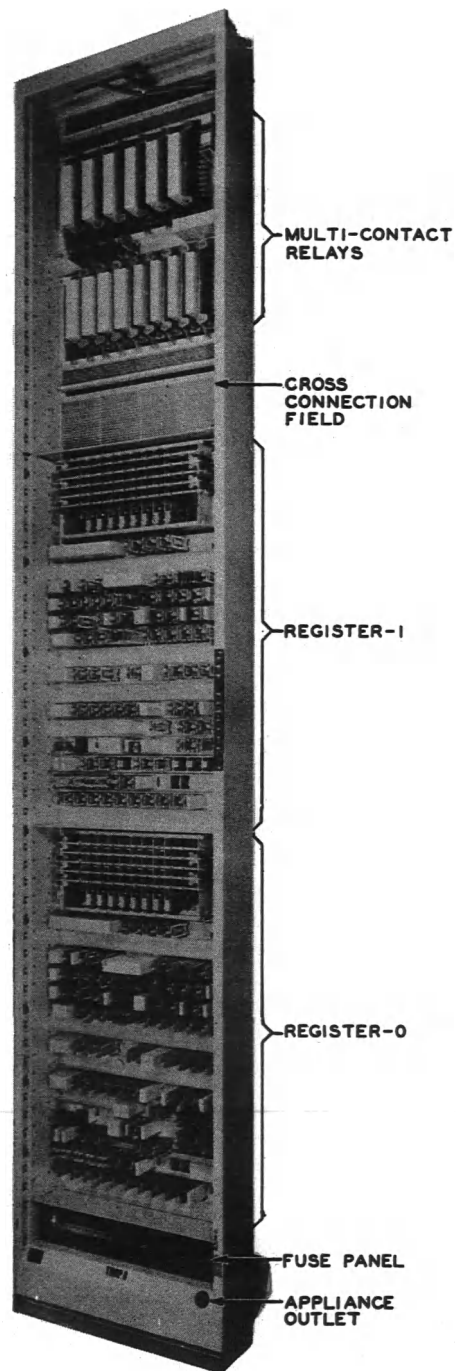
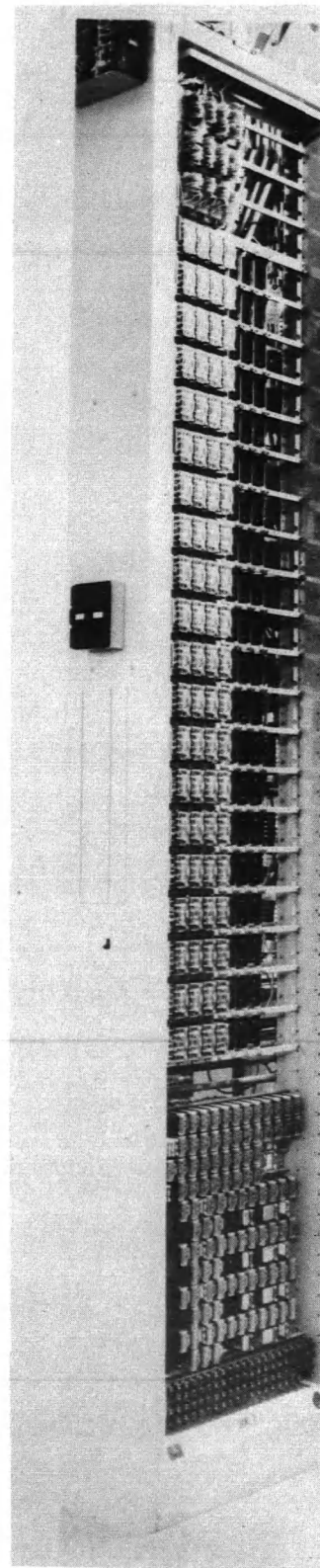
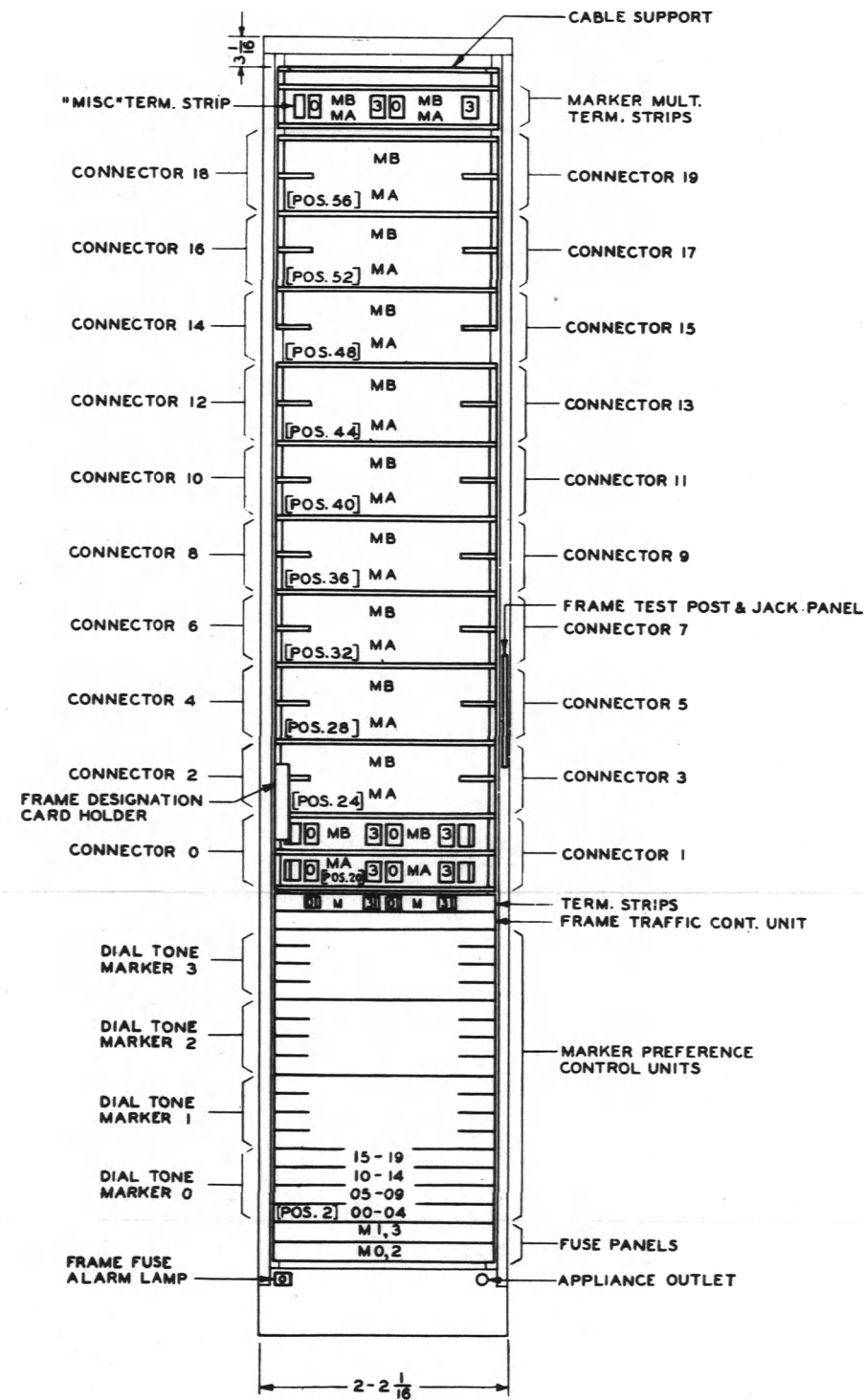


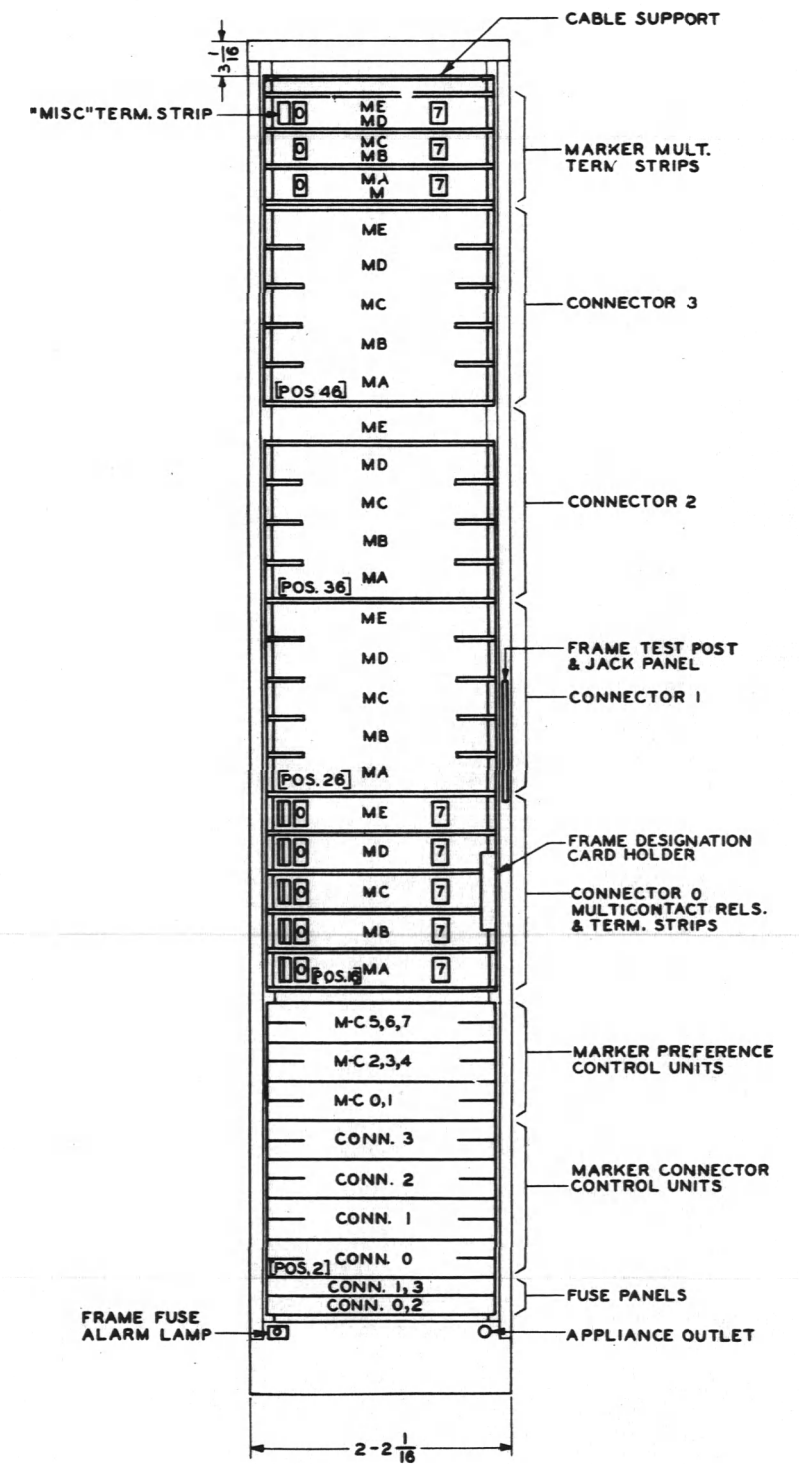
FIG. 25 - TANDEM REVERTIVE PULSE INCOMING REGISTER



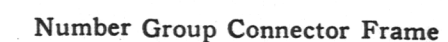
ORIGINATING REGISTER MARKER CONNECTOR



Line Link Marker Connector Frame



Originating and Incoming Register Marker Connector Frames



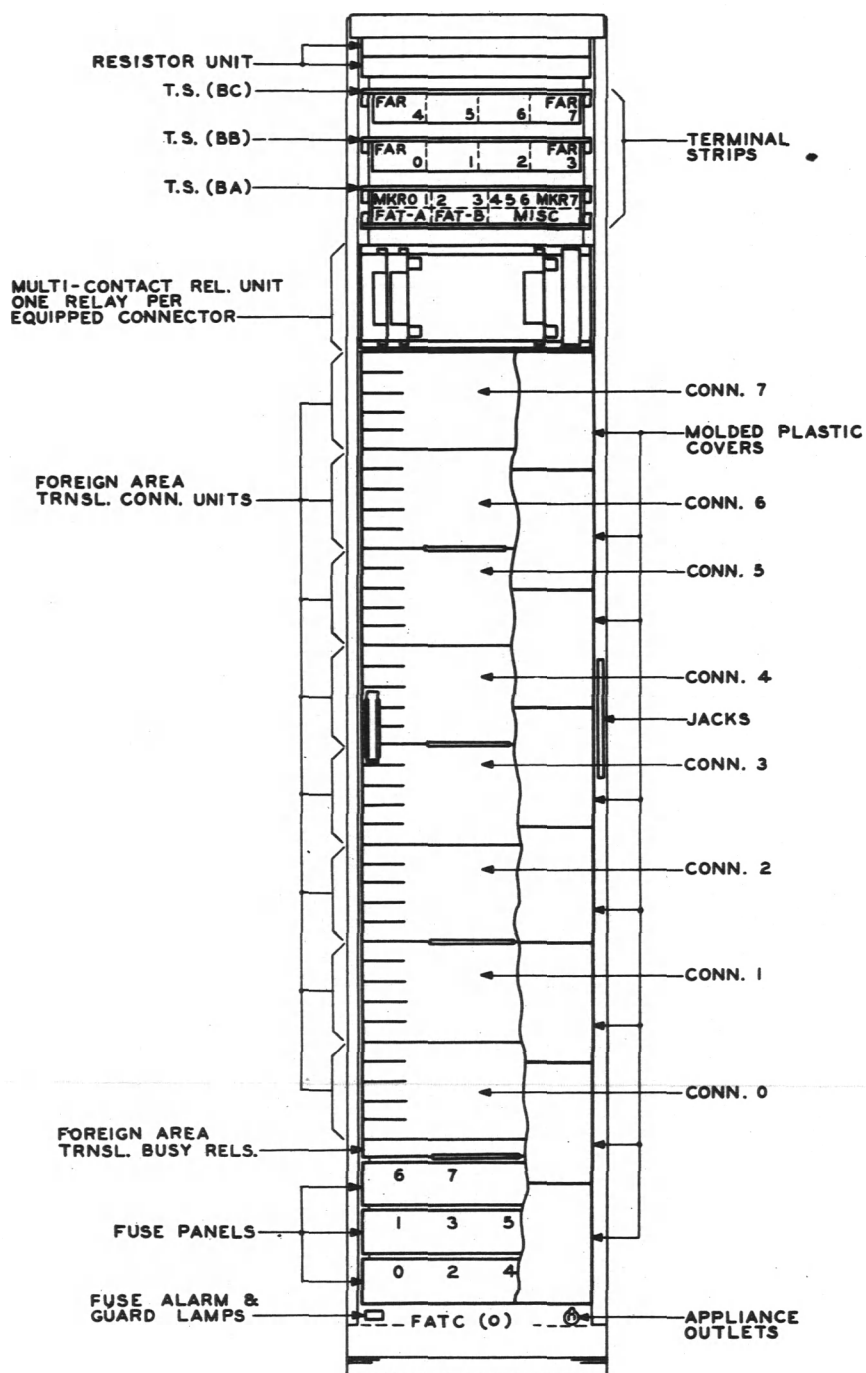
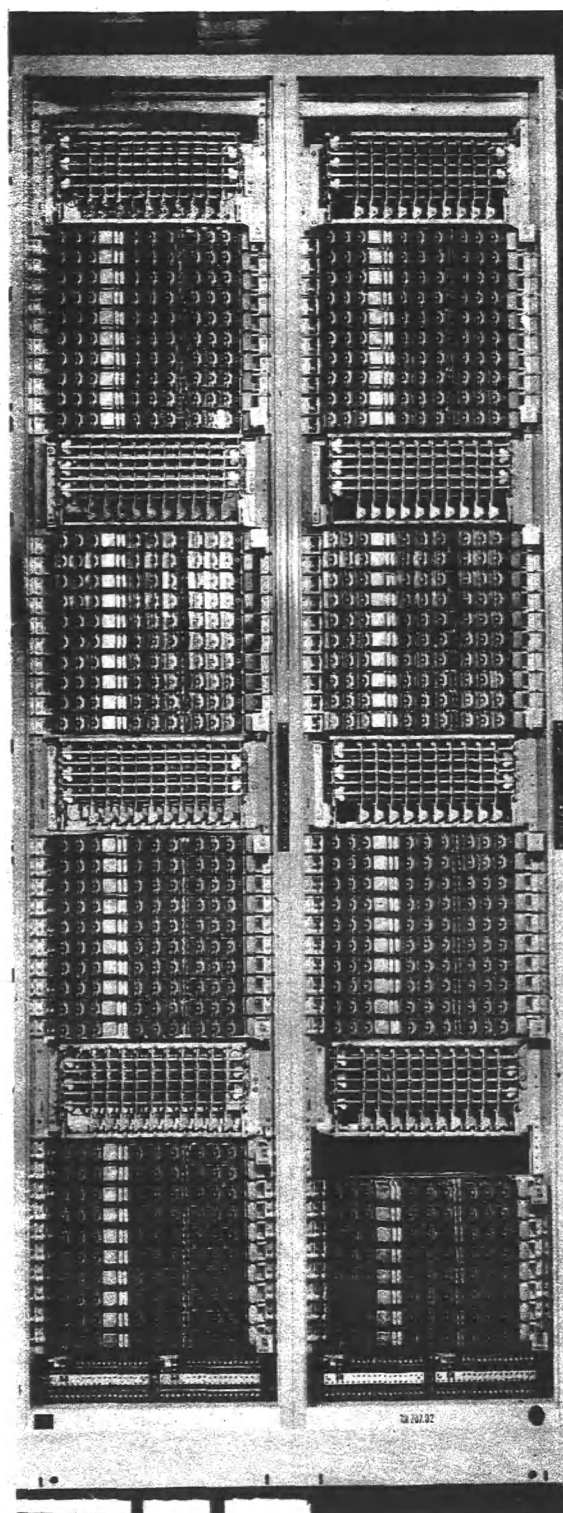
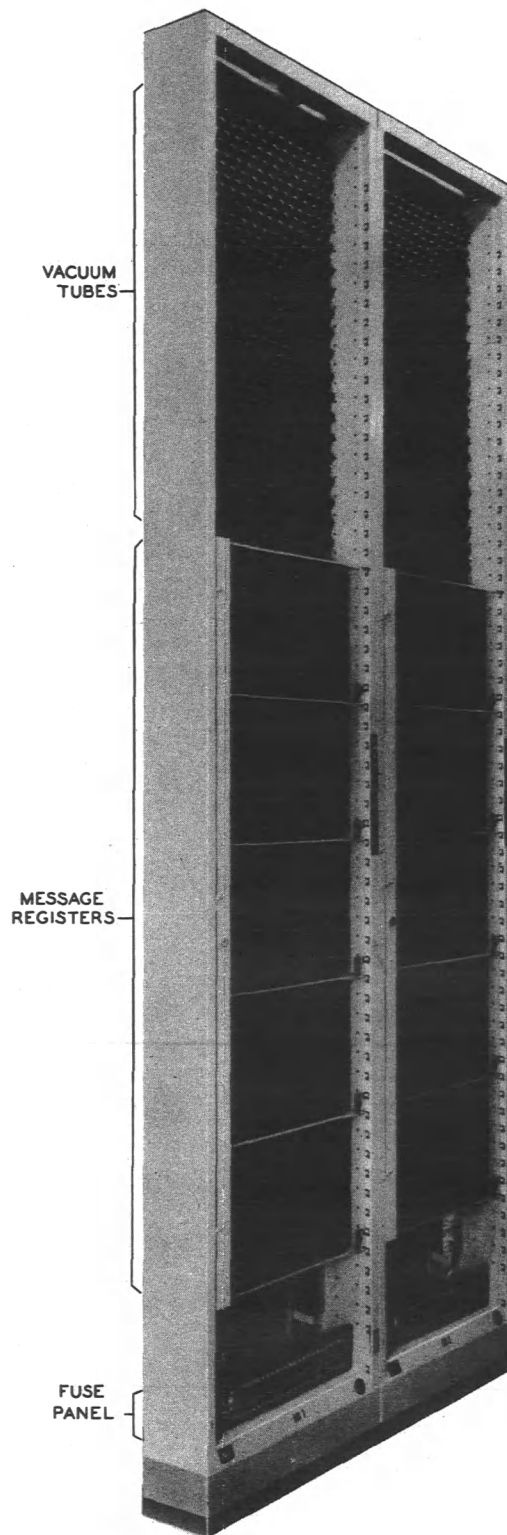


FIG. 28 - FOREIGN AREA TRANSLATOR CONNECTOR FRAME



Trunk Units on Relay Rack



Message Register Frame

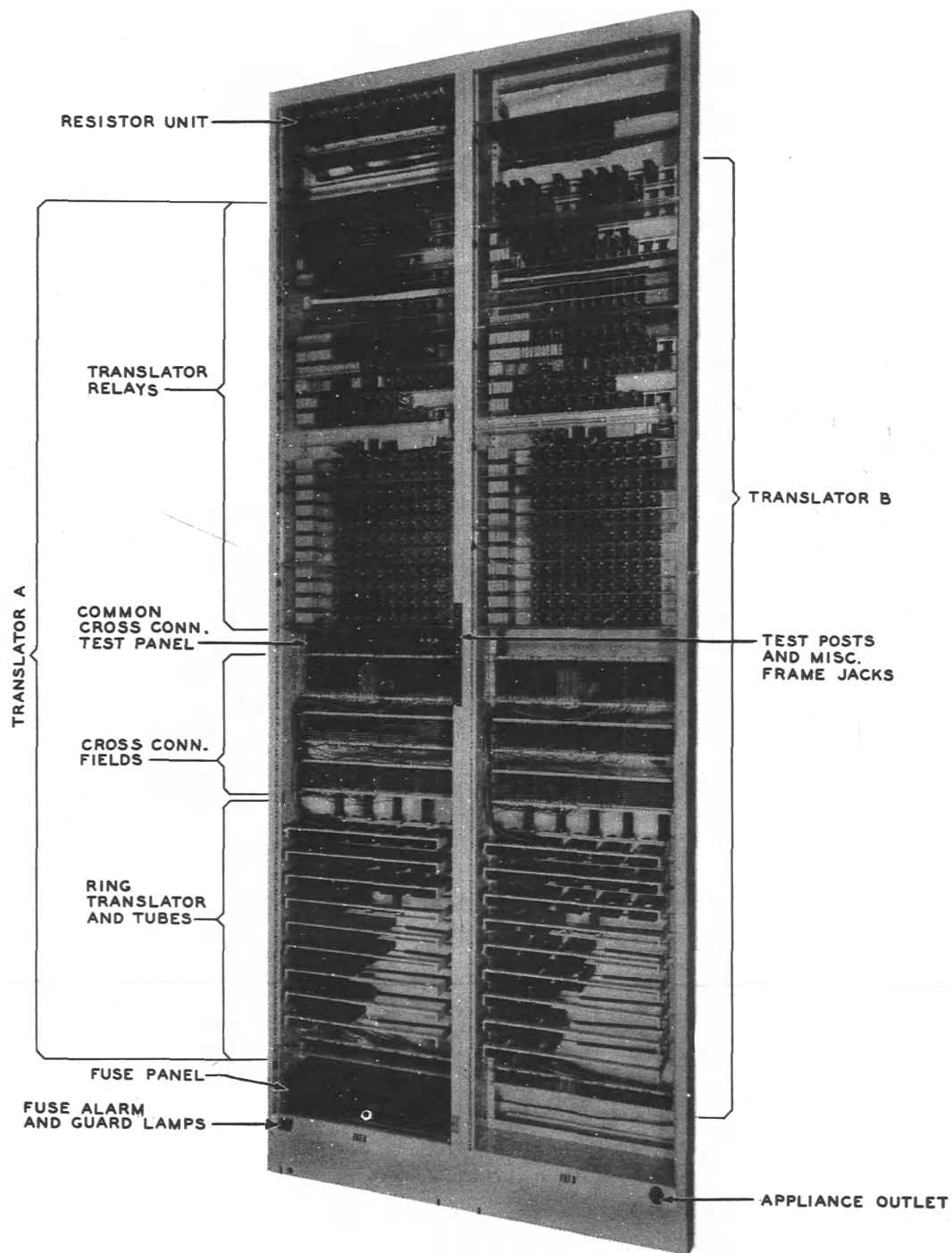
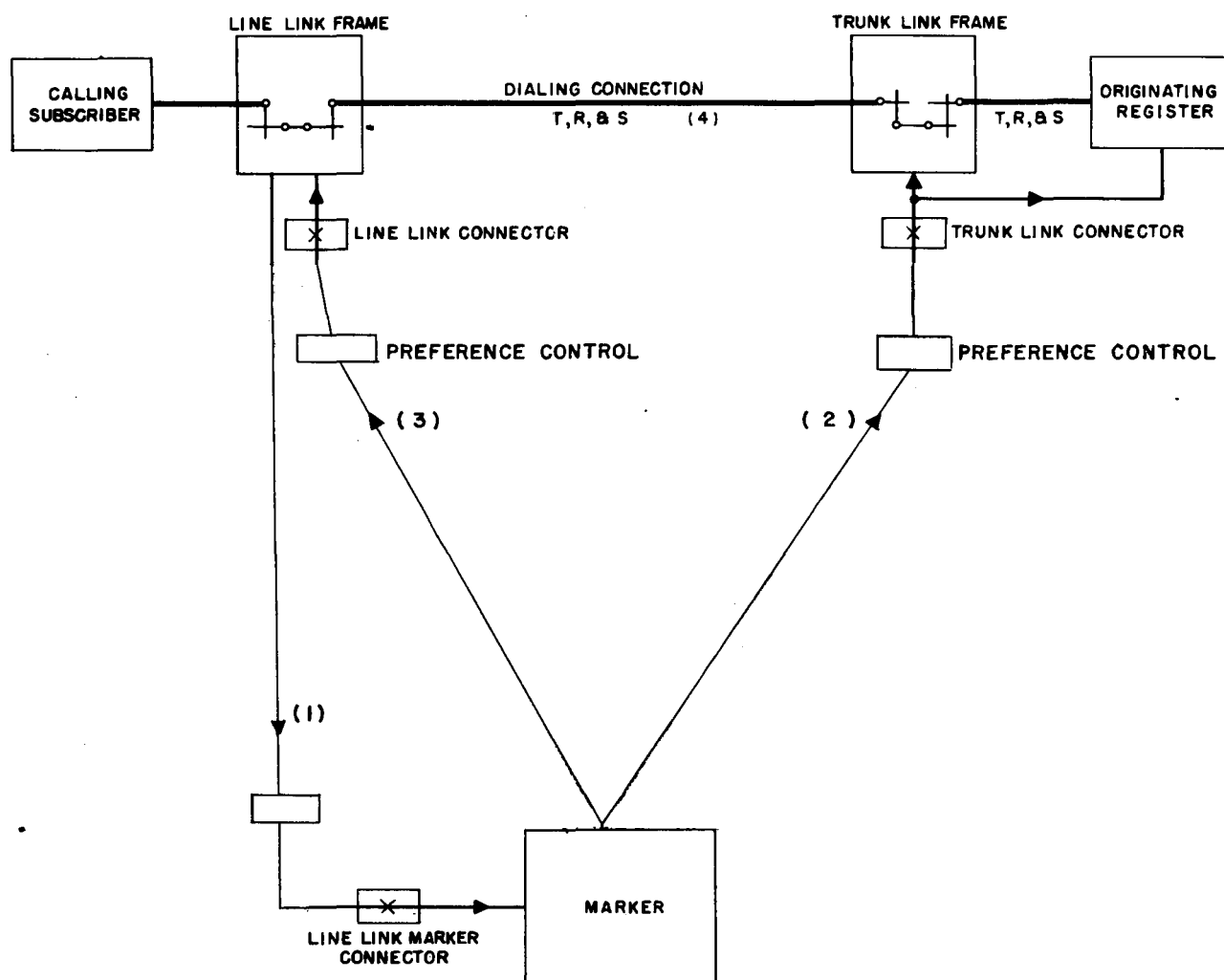
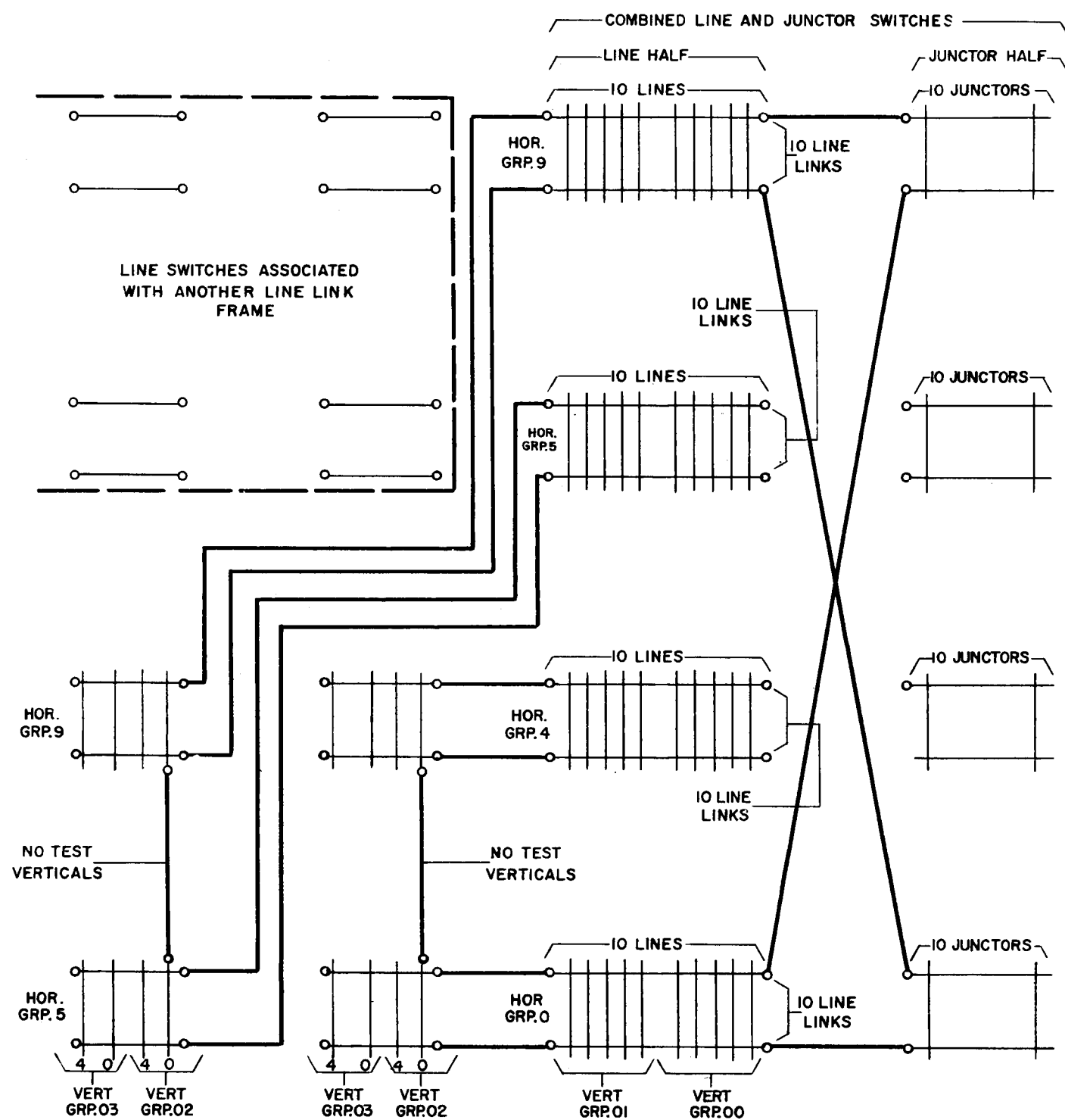


FIG. 31 - FOREIGN AREA TRANSLATOR FRAME

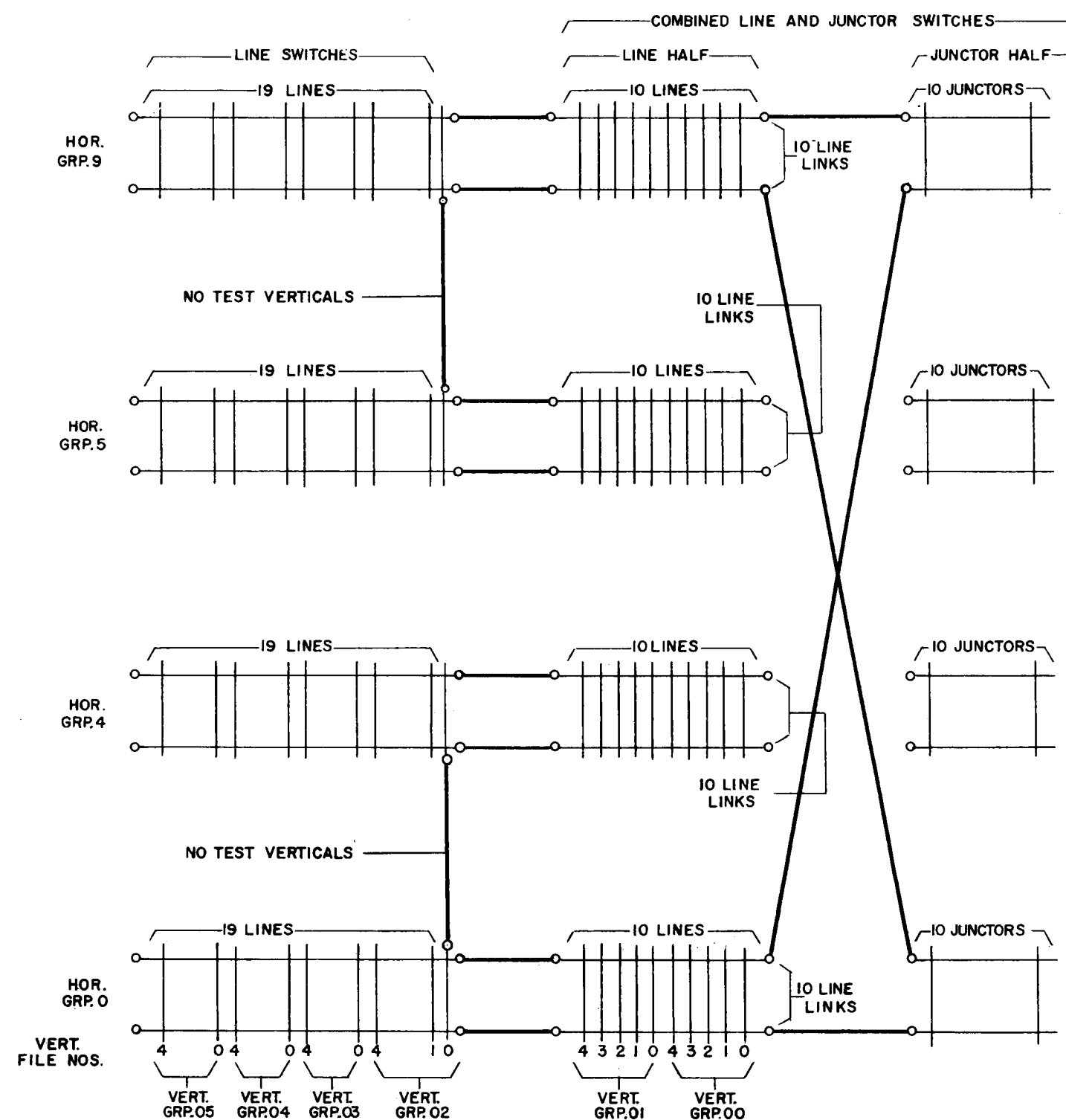


NOTES:
 1. PARENTHEetical NUMBERS INDICATE ORDER OF CONNECTIONS.
 2. ARROWS INDICATE DIRECTION OF CONNECTIONS.

FIG. 37
ESTABLISHING DIALING CONNECTION



BASIC LINE LINK FRAME
SPLIT FRAME 190 LINES



LINE LINK FRAME
NON-SPLIT 290 LINES

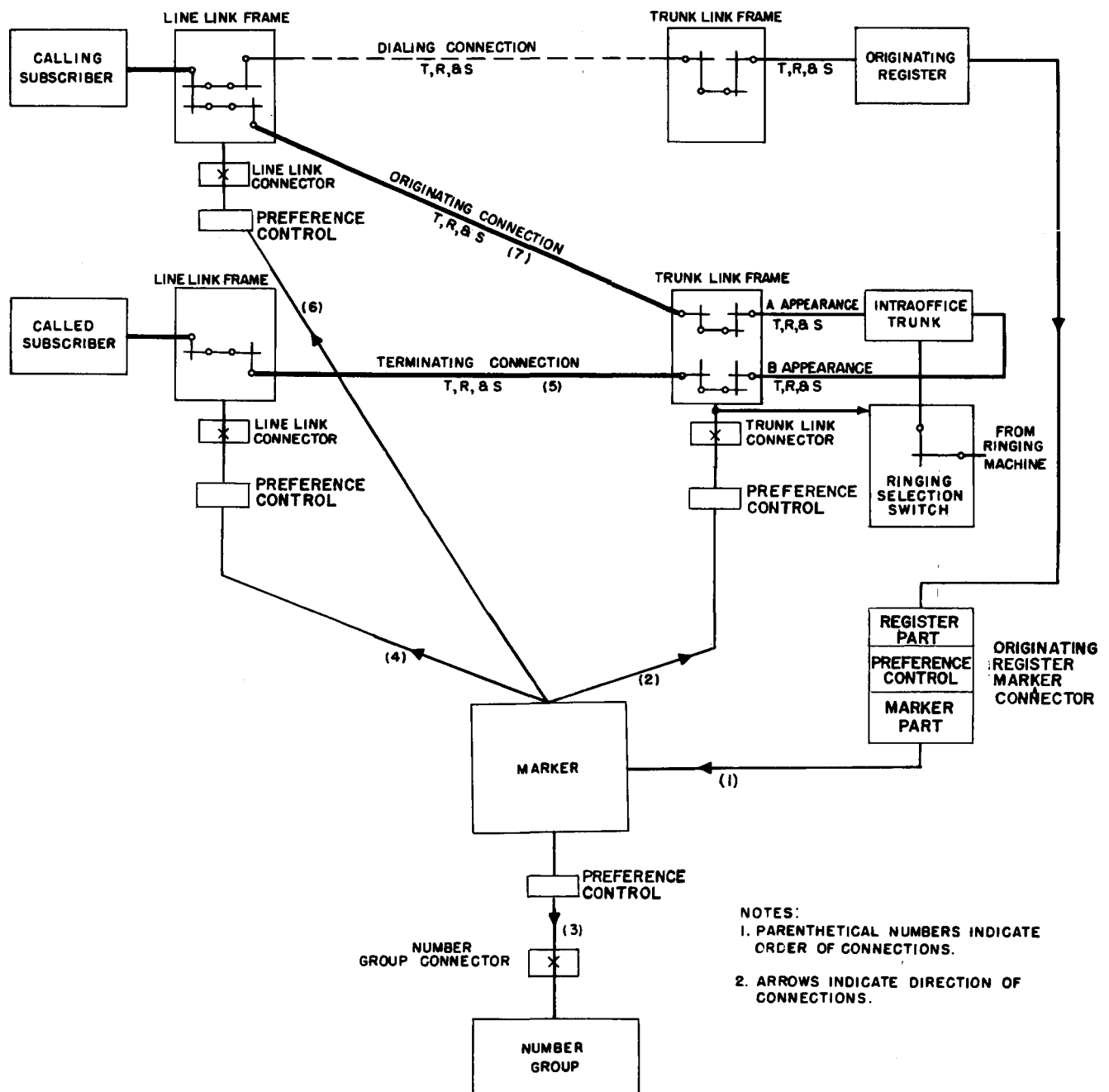


FIG. 39
ESTABLISHING INTRAOFFICE TRUNK CONNECTION

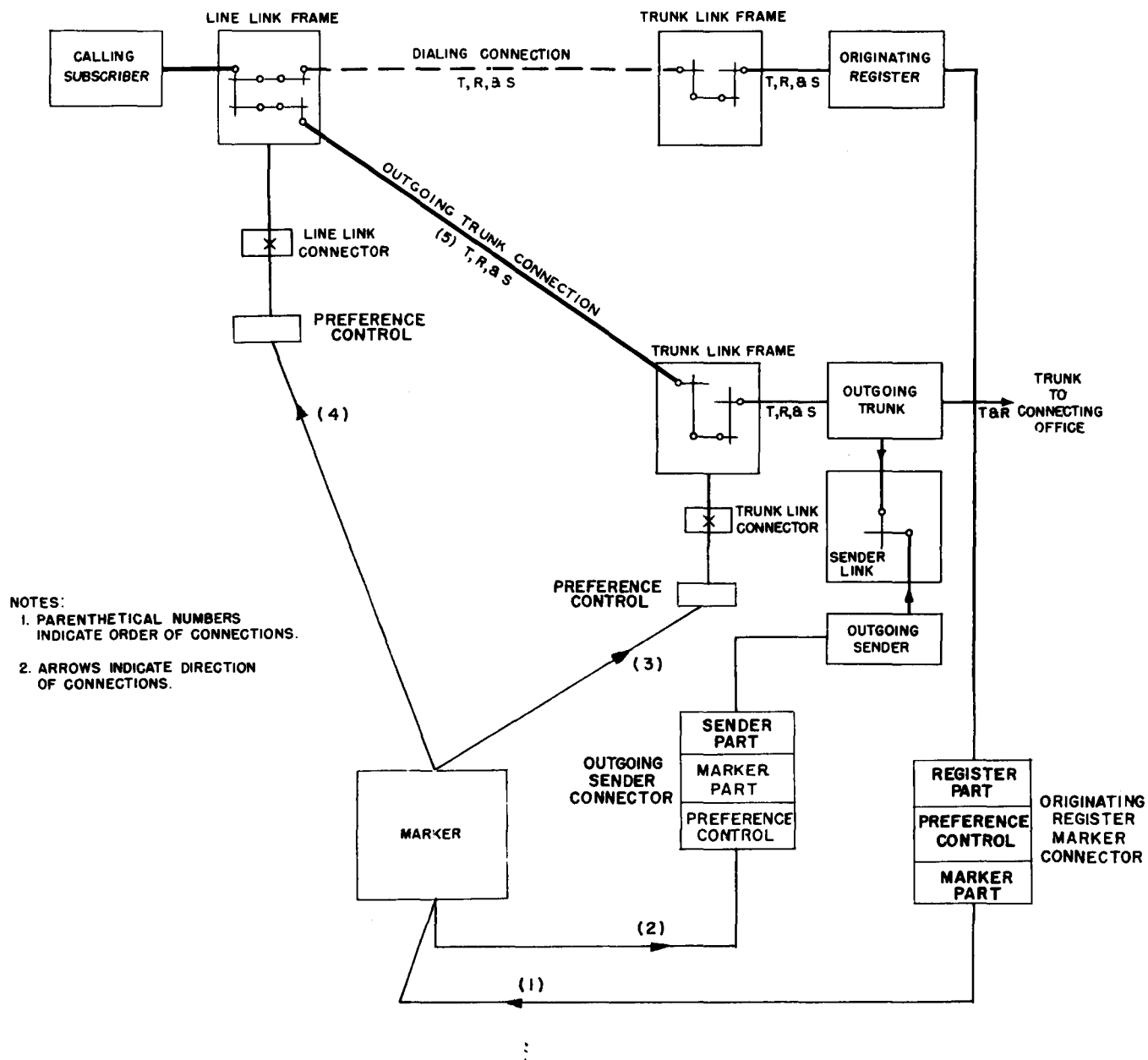


FIG. 40
ESTABLISHING OUTGOING TRUNK CONNECTION

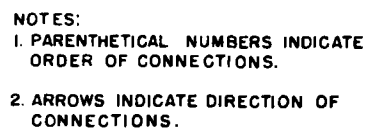
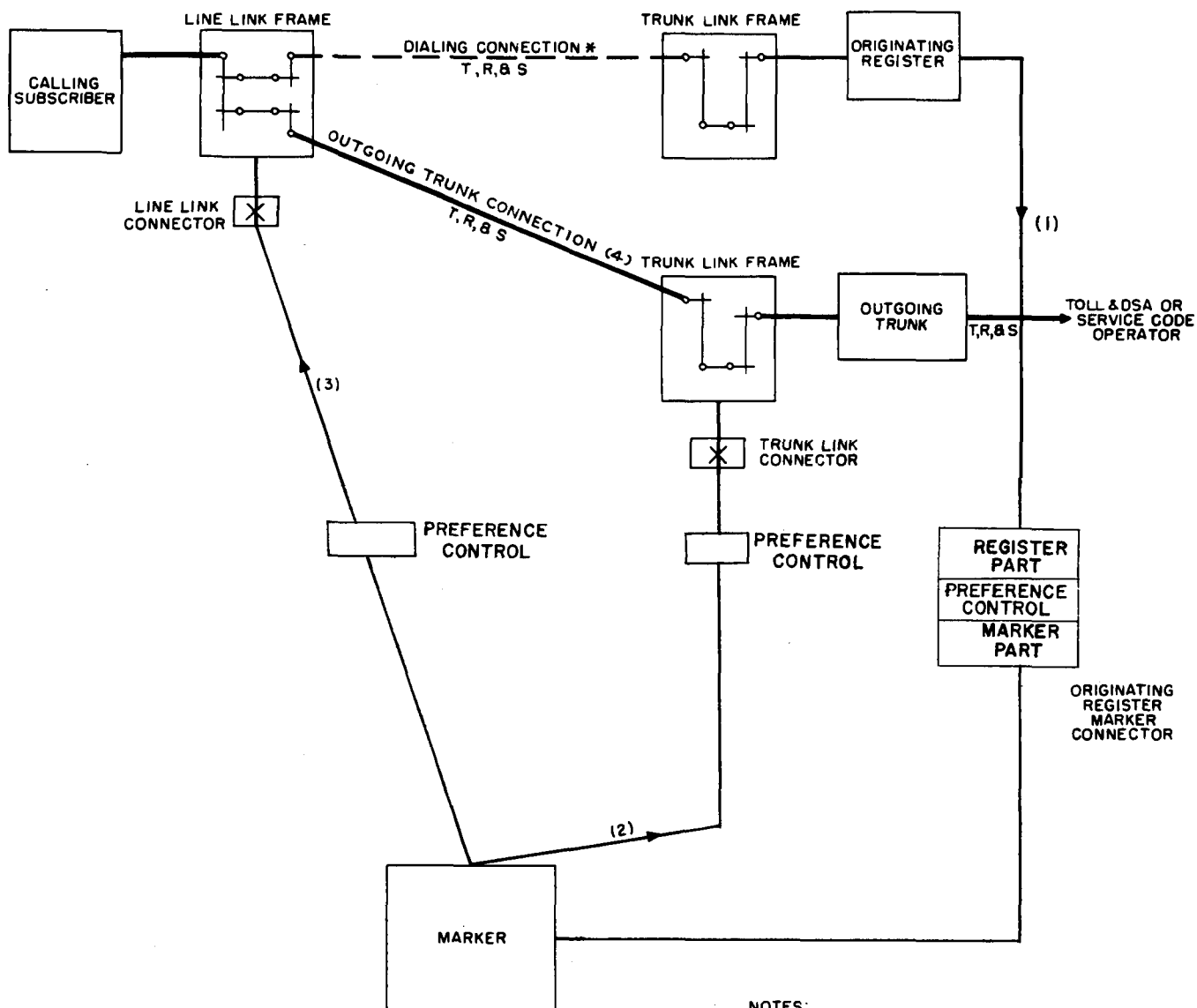


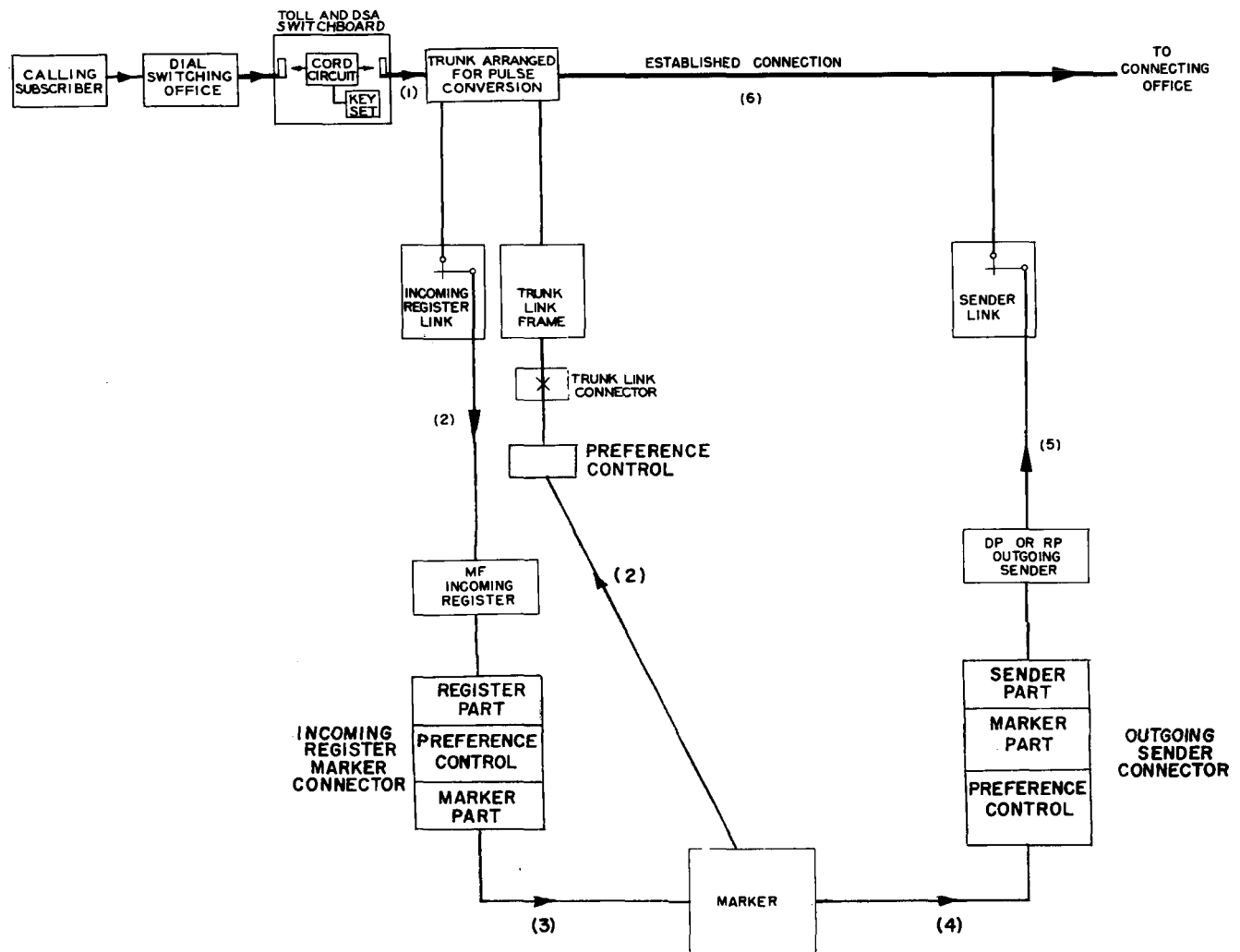
FIG. 41



- NOTES:
1. PARENTHETICAL NUMBERS INDICATE ORDER OF CONNECTIONS.
 2. ARROWS INDICATE DIRECTION OF CONNECTIONS.
 3. *MANUAL SUBSCRIBERS DO NOT RECEIVE DIAL TONE.

FIG. 43
ESTABLISHING TOLL AND DSA OPERATOR
SERVICE CODE, OR
MANUAL TRUNK CONNECTION





- NOTES:
1. PARENTHETICAL NUMBERS INDICATE ORDER OF CONNECTIONS.
 2. ARROWS INDICATE DIRECTION OF CONNECTIONS.

FIG. 48
OUTGOING CALL FROM TOLL AND DSA SWITCHBOARD
(PULSE CONVERSION)



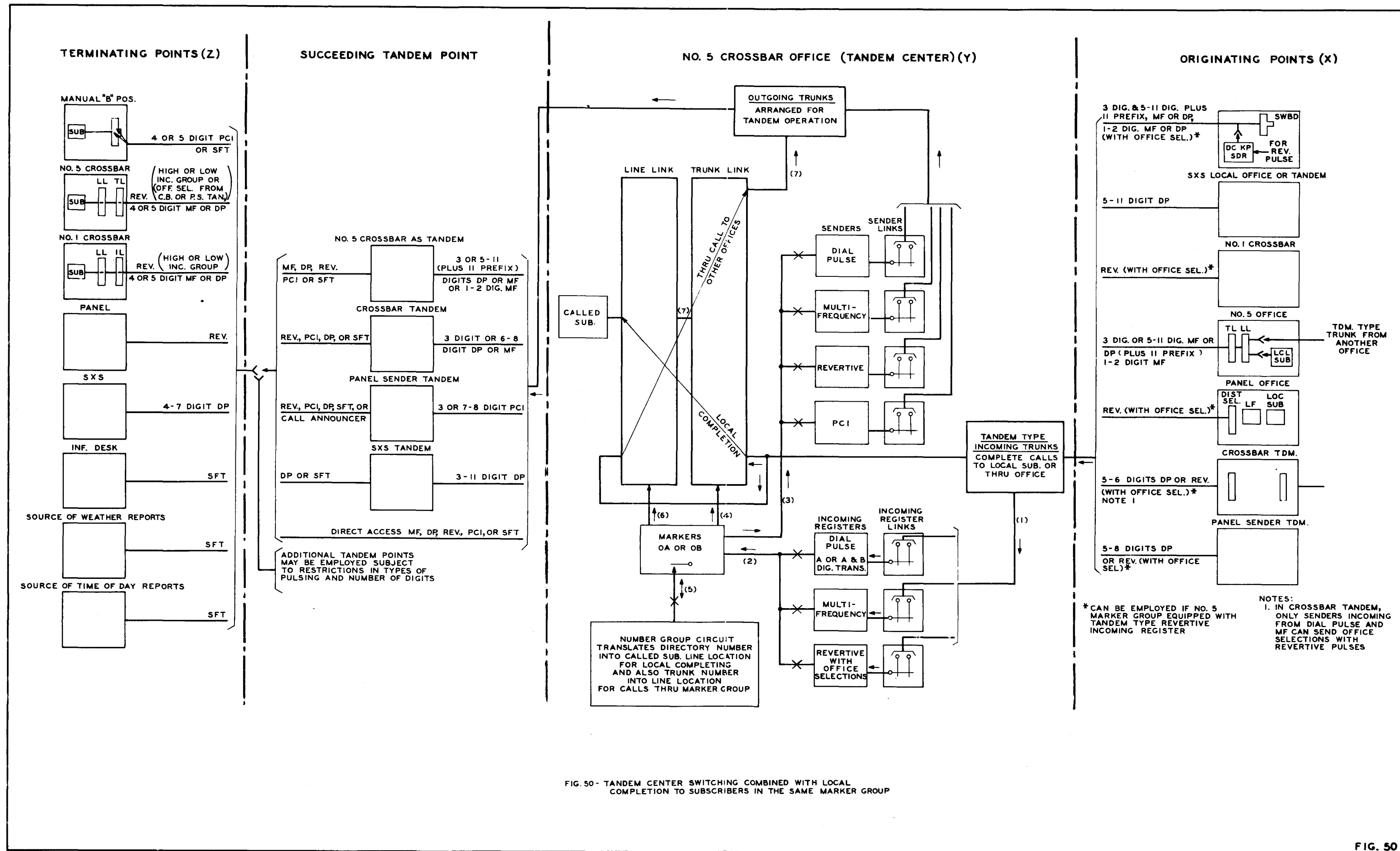


FIG. 50- TANDEM CENTER SWITCHING COMBINED WITH LOCAL COMPLETION TO SUBSCRIBERS IN THE SAME MARKER GROUP

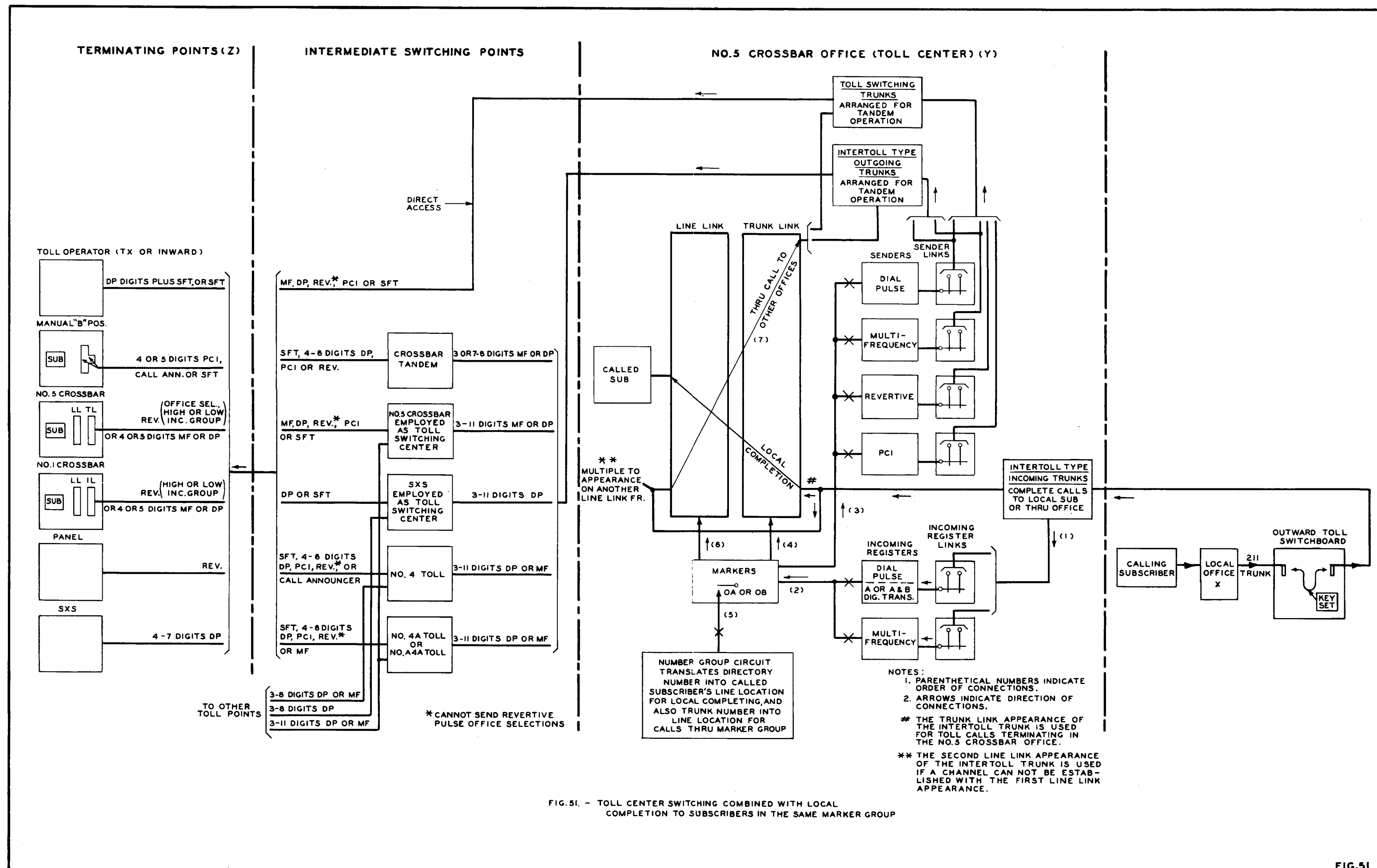


FIG. 51. - TOLL CENTER SWITCHING COMBINED WITH LOCAL COMPLETION TO SUBSCRIBERS IN THE SAME MARKER GROUP

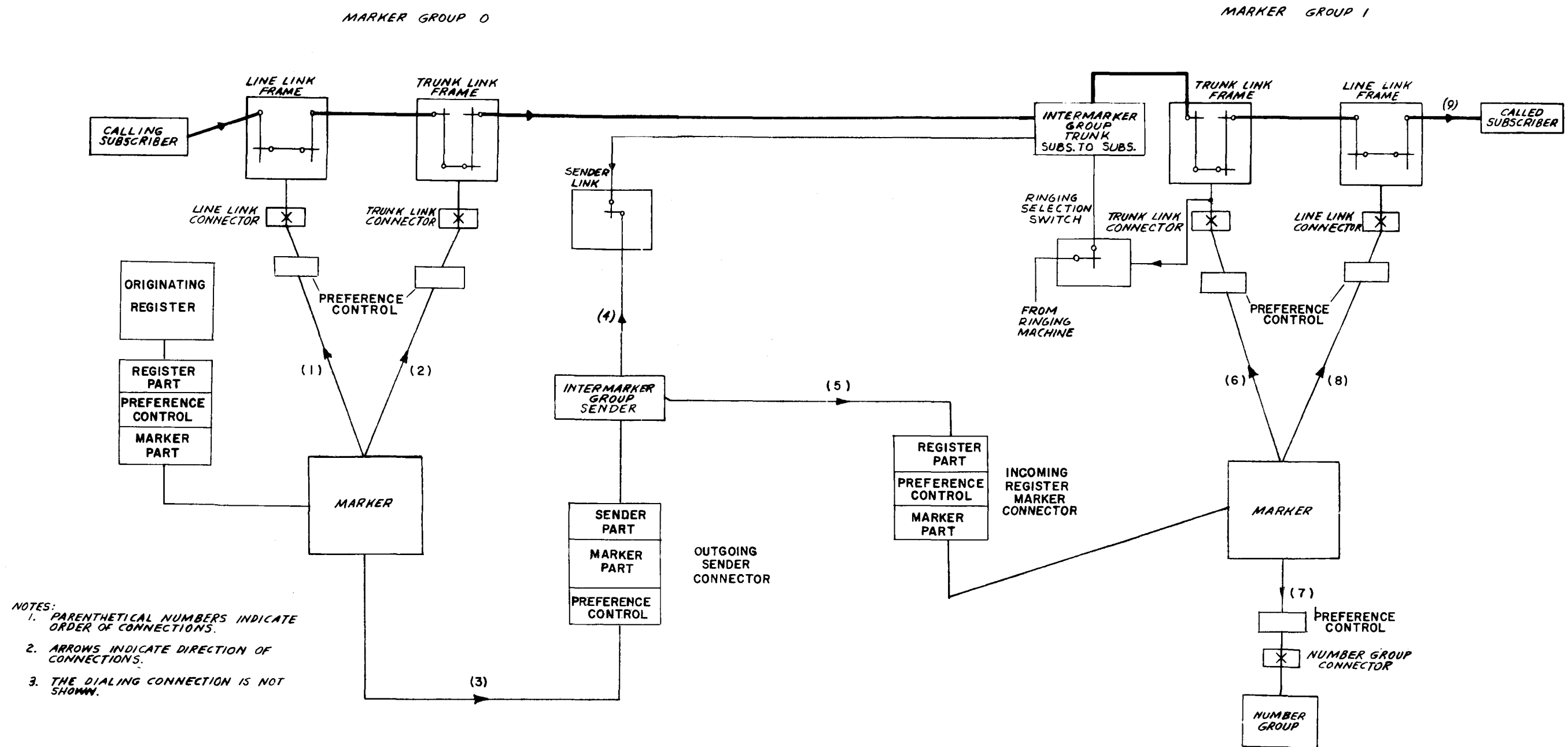


FIG. 52
INTERMARKER GROUP TRUNK CONNECTION
SUBSCRIBER TO SUBSCRIBER

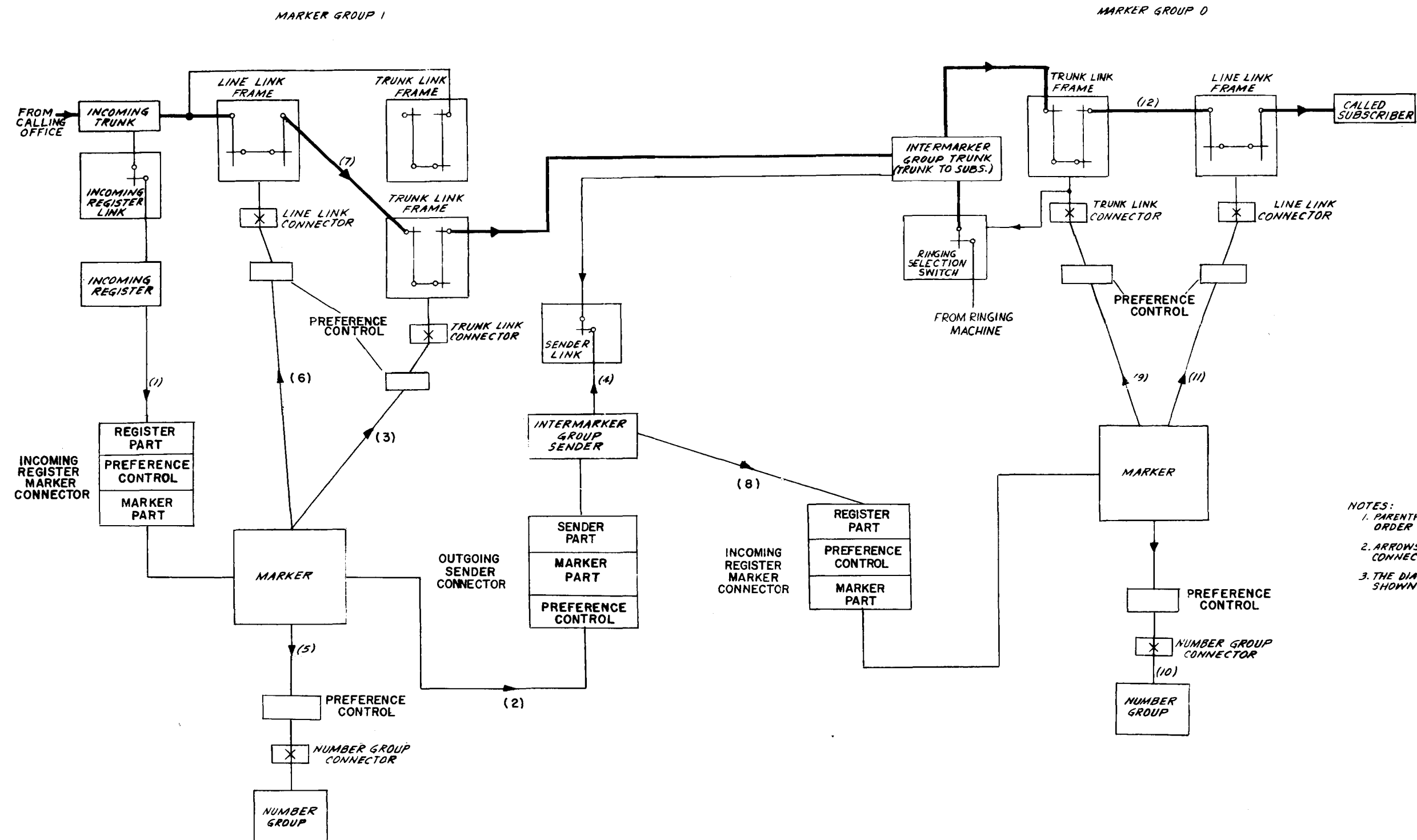


FIG. 54
INTERMARKER GROUP TRUNK CONNECTION
TRUNK TO SUBSCRIBER

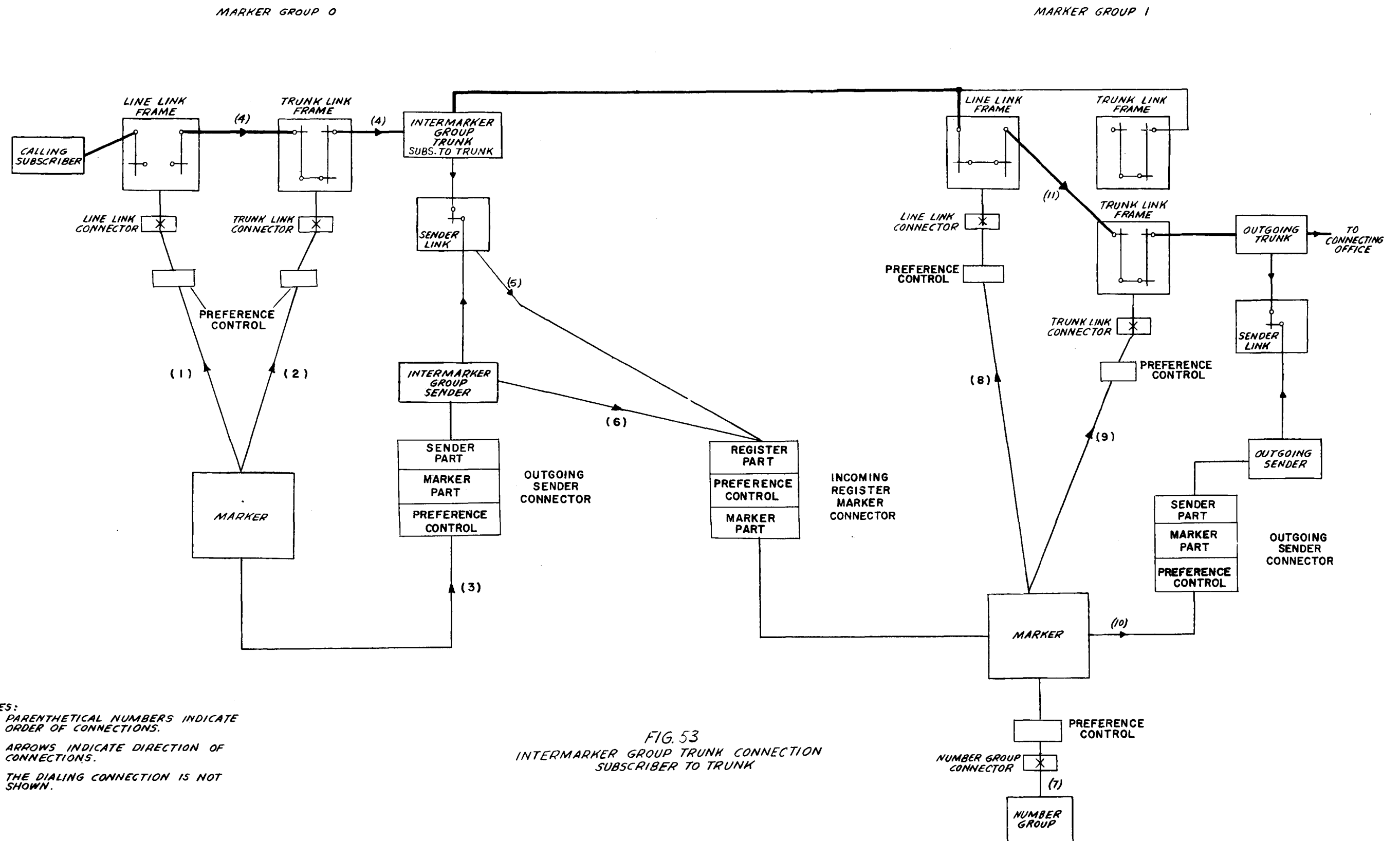
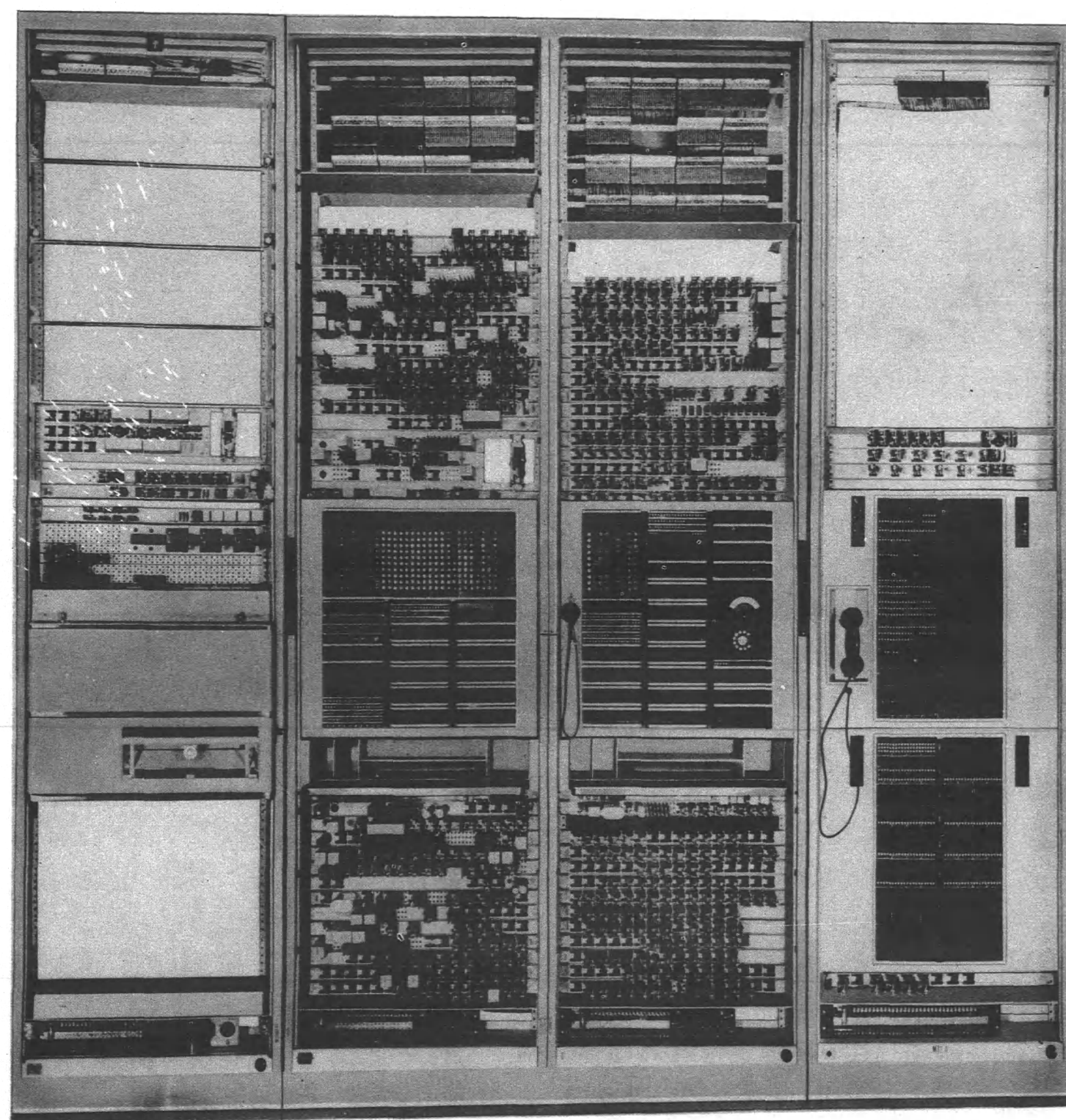
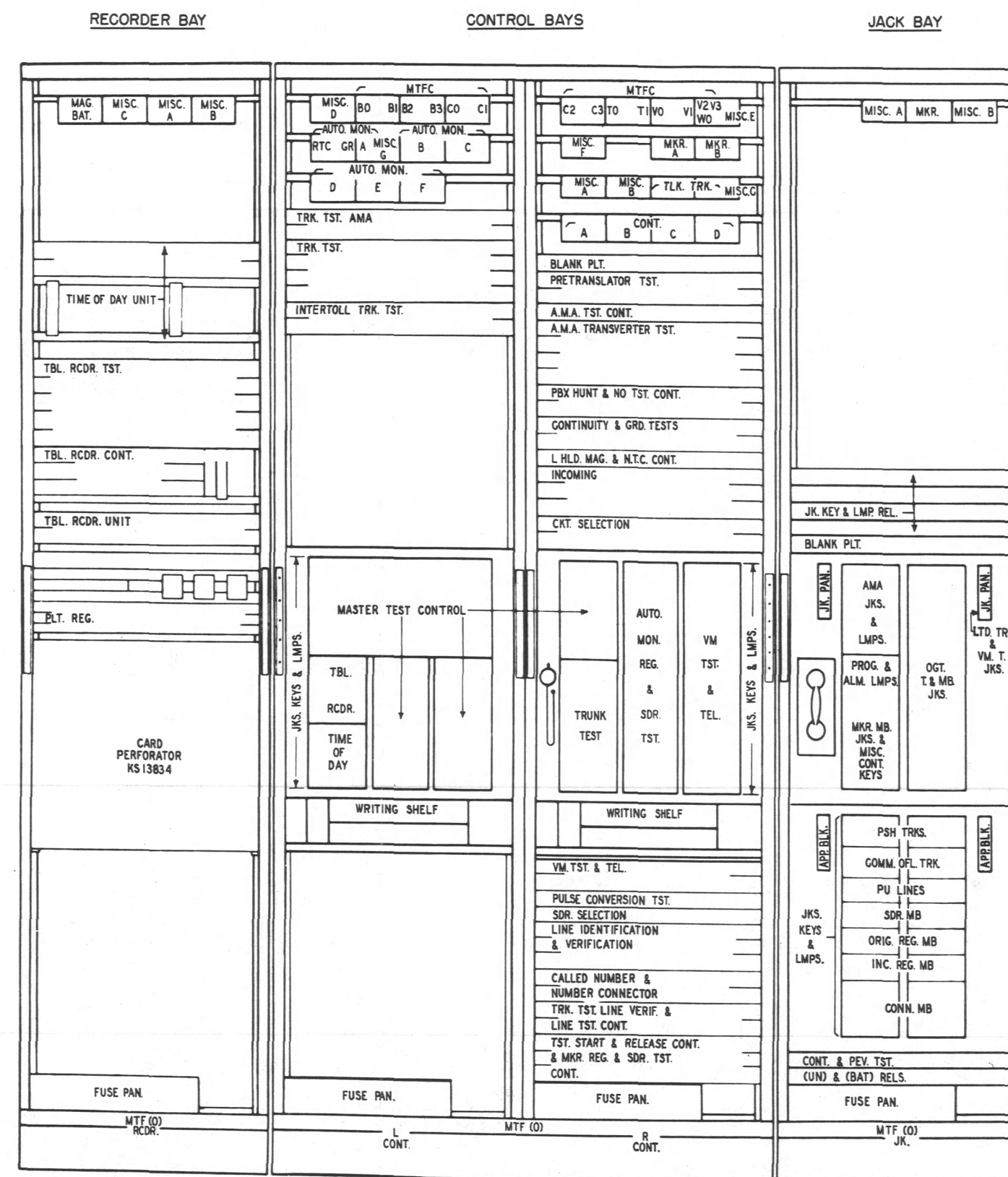


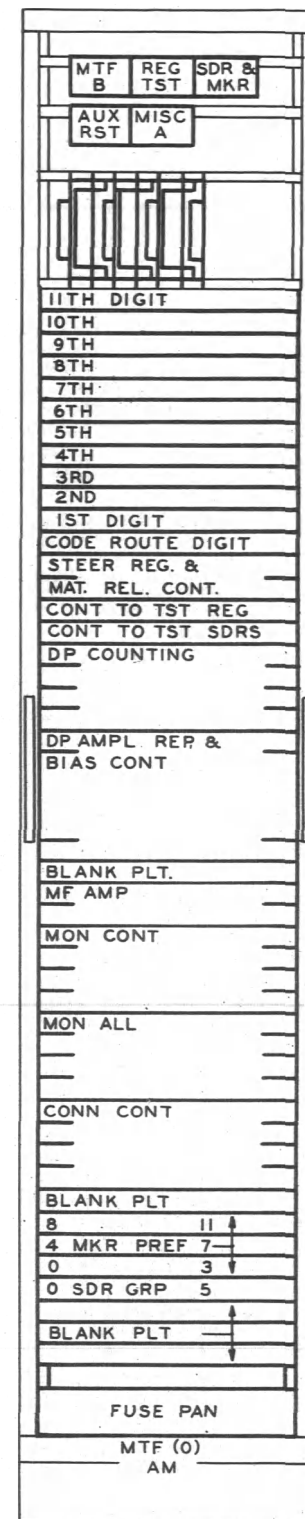
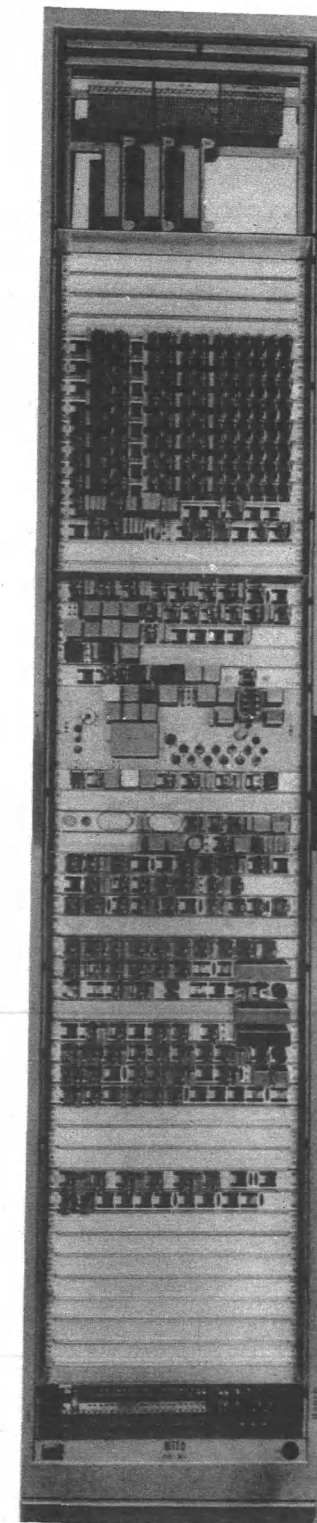
FIG. 53
INTERMARKER GROUP TRUNK CONNECTION
SUBSCRIBER TO TRUNK



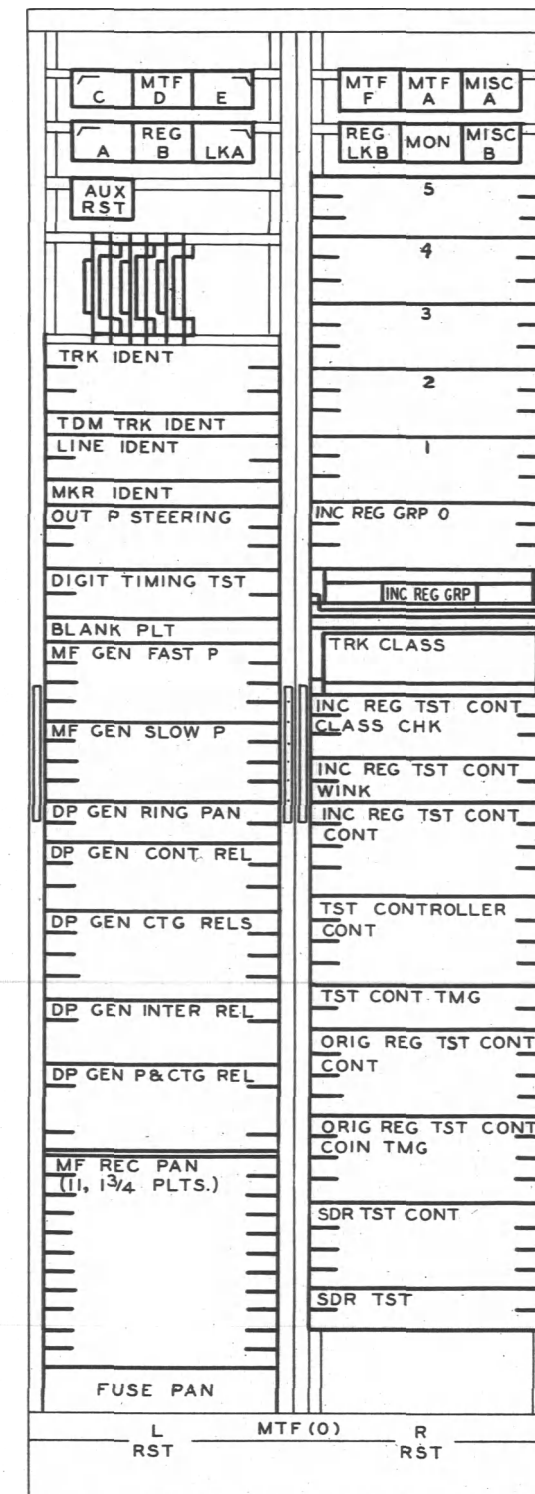
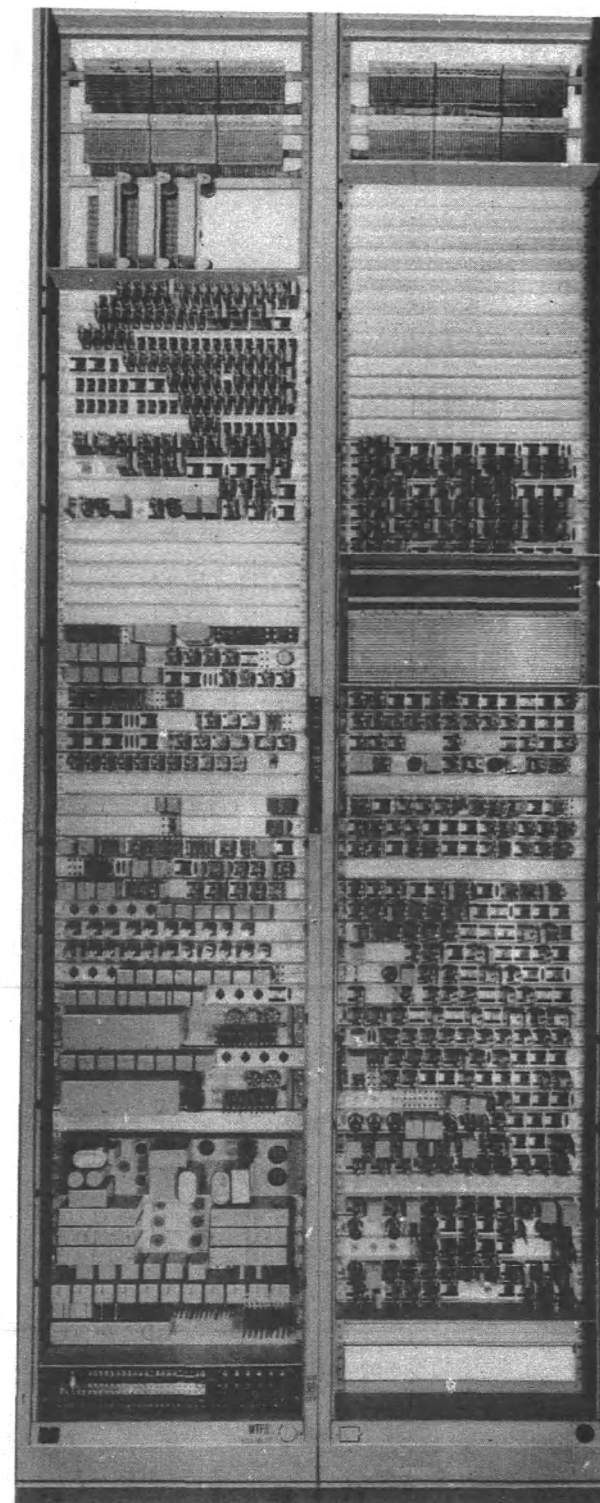


MASTER TEST FRAME
RECORDER, CONTROL, AND JACK BAYS

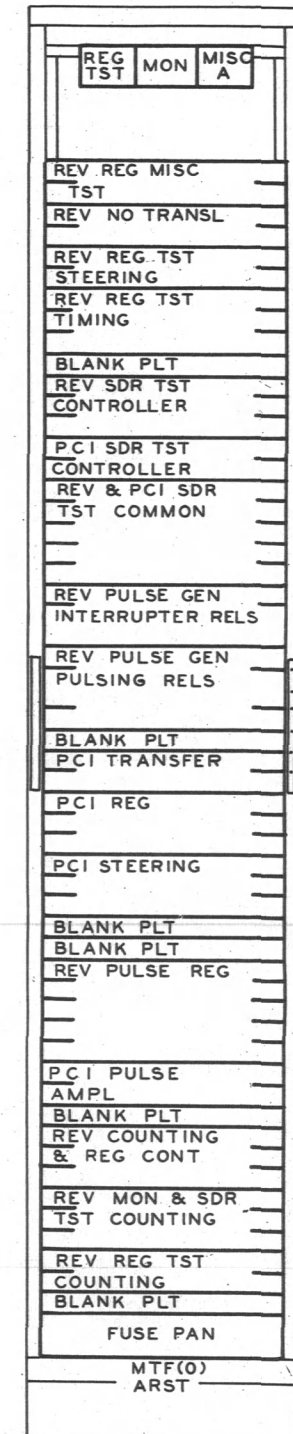
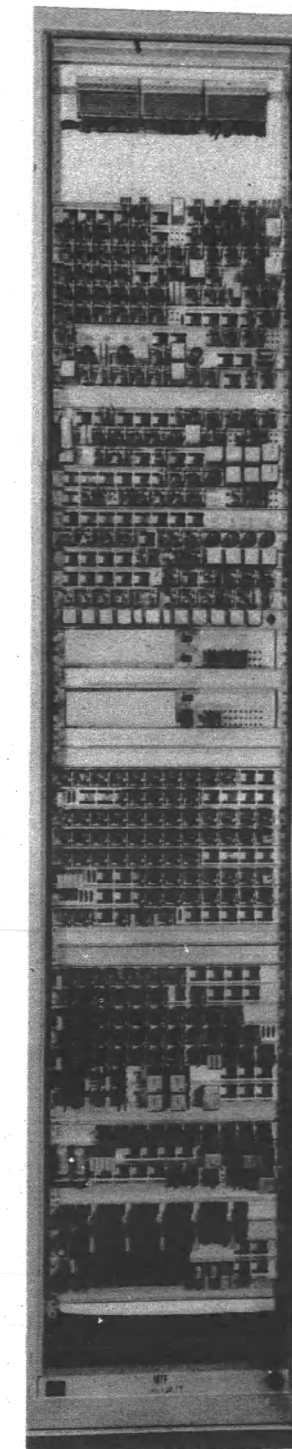




AUTO MON BAY



REG & SDR TEST BAYS



AUX REG & SDR TST BAY

MASTER TEST FRAME
AUTOMATIC MONITOR, REGISTER AND SENDER TEST BAYS

CONNECTOR
MULTICONTACT RELAYS

MARKER CONNECTOR CONTROL
AND PREFERENCE RELAY UNITS

FUSE PANEL

TERMINAL STRIPS

CONTROLLER UNIT

MASTER TEST CONNECTOR FRAME

E-3638 (2-54)

	0	5	10	15	20	25	29																												
8	TI	MIPTATKT	SRT	TKT	MLV	TLV	LVF	LVM	MOR	MIR	MOS	TRS	GT5	PRT	MKR	TV	REC	TMG	DR	0	1	2	3	4	5	6	7	8	9	EMG	DR				
7	MLF	D	MF	LIT	2DT	ITR	RV	SOG	TOG	TER	ROA	SOM	NSO	NSI	FLG	SCB	RPB	RPABRPSA	DRT-DRA	0	1	2	3	4	5	6	7	8	9	EMG	DRT-DRA				
6	FR	0	1	2	3	4	5	6	7	8	9	FR	CN	RP	0	1	2	3	4	CN-RG-RST	0	1	2	3	4	5	6	7	8	9	EMG	CN-RG-RST			
5	CN-RG	0	1	2	3	4	5	6	7	8	9	CN-RG	0	1	2	3	4	5	6	7	8	9	HT	TT-T	TT-T	TT-T	TT-T	TT-T	TT-T	TT-T	TT-T	TT-T			
4	LT	TT	FVD	XII	II	OA	OB	PHC	THC	OR	TAN	TOL	INC	RO	FAC	TRK	TR2	OBS	OBS2	0	1	2	3	4	5	6	7	8	9	LL	LL				
3	PS	PD	PK	CR	SCN	SCK	MAN	2P	OBS	NOB	CNR	CM	3	A	B	C	SD	PCK	PRL	RLK	PTR	XX	TST	M	SPL	NC	NT	NTT	MPT	NH	NN				
2	FR	0	1	2	3	4	5	6	7	8	9	OSG	0	1	2	3	4	5	6	7	8	9	10	11	12	LST	LSD	4DG	5DG	SC	TVT	OBS	NOB	AMA	RO
1	OSG	0	1	2	3	4	5	6	7	8	9	OSG	0	1	2	3	4	5	6	7	8	9	10	11	12	LST	LSD	4DG	5DG	SC	TVT	OBS	NOB	AMA	RO
0	A	0	1	2	3	4	5	6	7	8	9	A	0	1	2	3	4	5	6	7	8	9	10	11	12	LST	LSD	4DG	5DG	SC	TVT	OBS	NOB	AMA	RO
8	A	0	1	2	3	4	5	6	7	8	9	A	0	1	2	3	4	5	6	7	8	9	10	11	12	LST	LSD	4DG	5DG	SC	TVT	OBS	NOB	AMA	RO
7	G	0	1	2	3	4	5	6	7	8	9	G	0	1	2	3	4	5	6	7	8	9	10	11	12	LST	LSD	4DG	5DG	SC	TVT	OBS	NOB	AMA	RO
6	G	0	1	2	3	4	5	6	7	8	9	G	0	1	2	3	4	5	6	7	8	9	10	11	12	LST	LSD	4DG	5DG	SC	TVT	OBS	NOB	AMA	RO
5	CP	0	1	2	3	4	5	6	7	8	9	CP	0	1	2	3	4	5	6	7	8	9	10	11	12	LST	LSD	4DG	5DG	SC	TVT	OBS	NOB	AMA	RO
4	NGCU-TH	0	1	2	3	4	5	6	7	8	9	NGCU-TH	0	1	2	3	4	5	6	7	8	9	10	11	12	LST	LSD	4DG	5DG	SC	TVT	OBS	NOB	AMA	RO
3	T	0	1	2	3	4	5	6	7	8	9	T	0	1	2	3	4	5	6	7	8	9	10	11	12	LST	LSD	4DG	5DG	SC	TVT	OBS	NOB	AMA	RO
2	PN	TN	PTN	PBN	FNA	FNB	OV	BY	OFH	PUL	LCH	TCH	LIN	TIN	BN	RI	TBI	TBH	RSK	LI	TCKI	EN	SRK	RCK2	RCK3	AR	0	1	2	3	4	AR			
1	FT	0	1	2	3	4	5	6	7	8	9	FT	0	1	2	3	4	5	6	7	8	9	10	11	12	LST	LSD	4DG	5DG	SC	TVT	OBS	NOB	AMA	RO
0	FT	0	1	2	3	4	5	6	7	8	9	FT	0	1	2	3	4	5	6	7	8	9	10	11	12	LST	LSD	4DG	5DG	SC	TVT	OBS	NOB	AMA	RO

NO.5 CROSSBAR SYSTEM
TROUBLE RECORDER CARD

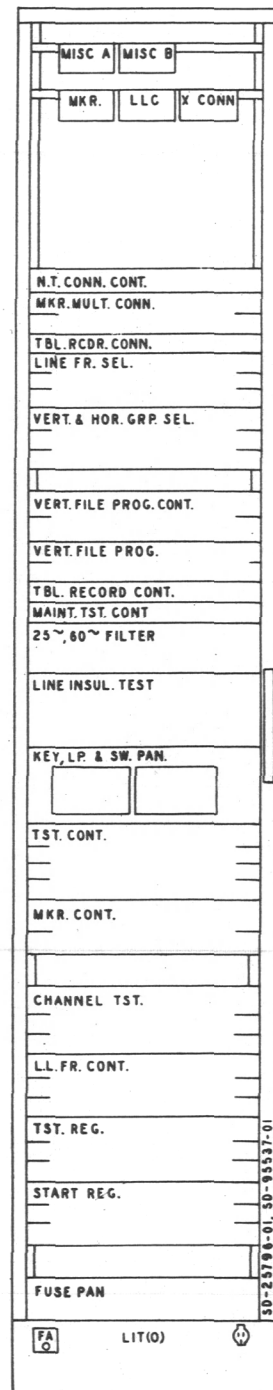
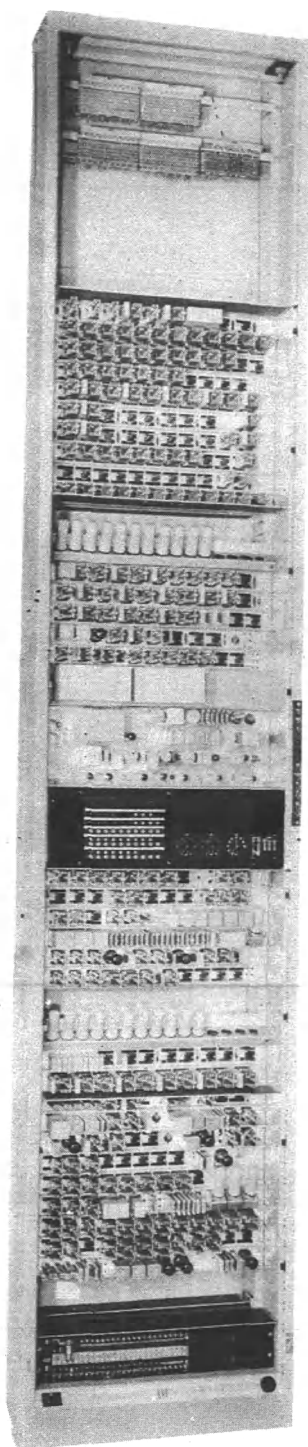
	30	35	40	45	50	55	59																								
8	TM	CKG	CK7	CK1	CK2	CK4	DNK	RK	IC	TOK	C14	C13	C12	IRY	C11	P5	RLR	RL	TR	TM1	TM2	C1FA	FABG	FACK	OF	TBY	EXT	RB	BY	MONTH	
7	TEA	TGR	OPI	ITR	2TR				P	DTK	PTI	DTN	PT	PAK	CK	PI	LC	DS	RD	TBL	PTS		BSP	ASP	DA	HR	SC	SY	NS	YEAR	
6	RN	MO	MG	SPA	SKP				XPL	X	XRST	XRL	XIC	XICK	XNL	XP	XR	XTL	XTC	XU	XTK	XPI	XTI	XUI	XCK	XOF	X2P	XVF	XET	XVG	
5	DT	0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9

OFFICE

MADE IN U.S.A.

TROUBLE RECORDER CARD

FIG.60



LINE INSULATION TEST FRAME

DIAL TONE JOB



ESTABLISHING THE DIALING CONNECTION

NO. 5 CROSSBAR OFFICES

	CONTENTS	PAGE
1.	GENERAL	3
2.	LINE RELAY OPERATION	3
3.	THE LINE LINK FRAME	4
4.	VERTICAL GROUP START RELAY OPERATION	4
5.	THE LINE LINK MARKER CONNECTOR	5
6.	RELAY CHAIN CIRCUITS IN THE MARKER CONNECTORS	5
7.	W AND Z RELAY COMBINATION FOR TRANSFERRING START LEADS	7
8.	MARKER CONTROL, CLASS, CHECK, AND ROUTE RELAY OPERATION	8
9.	CALLING LINE IDENTIFICATION AND SELECTION	9
	A. General	9
	B. Line Link Frame Identification	9
	C. Two-out-of-five Transfer Circuit	9
	D. Gating Control Circuit	10
	E. Junctor Sequence Walking Circuit	10
	F. Vertical Group Identification and Selection	11
	G. Horizontal Group Identification and Selection	11
	H. Vertical File Identification and Selection	12
	I. Marker Supervision During Line Identification and Selection	12
	J. Class-of-service Identification	13
10.	TRUNK LINK FRAME SELECTION, PREFERENCE, AND SEIZURE	13
	A. General	13
	B. Testing for an Idle Trunk Link Frame	14
	C. Testing for an Idle Originating Register	14
	D. Trunk Link Frame Preference	14
	E. Trunk Link Frame Seizure	15
	F. Recycle of Frame Memory Preference	15
11.	LINE LINK FRAME SEIZURE	15
12.	ORIGINATING REGISTER SELECTION	16
	A. Trunk Blocks and Trunk Groups	16
	B. Selection of Register	17
13.	CHANNEL SELECTION	18
	A. General	18
	B. Junctor Subgroup Selection	19
	C. Selection of the Group Line Links	20
	D. Selection of the Group of Trunk Links	20
	E. Test Check	20
	F. Channel Test and Selection	21
	G. Junctor Distribution	22
14.	FORWARDING CALLING LINE IDENTIFICATION AND CHANNEL NUMBER TO THE ORIGINATING REGISTER	23

CONTENTS	PAGE
15. SELECT AND HOLD MAGNET OPERATION	24
16. CONTINUITY TEST	25
17. DOUBLE CONNECTION TEST	26
18. TRANSFER OF SUPERVISION TO THE ORIGINATING REGISTER	26
19. MARKER RELEASE	27

FIGURES	PAGE
1 - Ten-vertical Unit 100-point Crossbar Switch and a Twenty-vertical Unit 200-point Crossbar Switch	
2 - Partial Perspective View of the Selection Elements of a Crossbar Switch	
3 - Crossbar Switch Selecting Mechanism	
4 - Wiring of a Typical Lead (VGTO) Through the Line Link Marker Connectors	
5 - Typical Multiple Arrangement of the Trunk Link Connector Frames . .	
TABLE A - Establishing the Dialing Connection - Major Functions	

1. GENERAL

1.01 This text outline is one of a group that describes the detailed circuit operation for the various types of calls and is associated with wire spring relay type circuits of No. 5 crossbar offices.

1.02 The basic equipment element used in the No. 5 crossbar office, is the crossbar switch (Fig. 1), from which the system receives its name. Section 971.505.01 contains the general description of the switch. For a more detailed study of the selection elements of the crossbar switch, refer to Figs. 2 and 3.

1.03 A telephone customer by lifting the receiver requests service. During normal traffic a number of other customers are also making requests. The No. 5 crossbar common control equipment (marker) must determine the origin of these requests. In so doing, it also determines which line will be served first. The equipment must then prepare itself to accept the customer's instructions, that is, the dialed digits of the called number. To do this, apparatus capable of interpreting and storing these digits (originating register) must be attached to the calling line. The marker tests this connection and then the originating register transmits dial tone to the calling customer. This entire operation is called Establishing the Dialing Connection and is shown on SC 701-1. After this connection is established, the customer can dial the desired number.

1.04 In the following description all FS references are associated with SD-26001-01 unless otherwise noted.

1.05 The major functions for establishing the dialing connection are summarized in Table A. Associated with these functions are the key relays, trouble recorder card punch indications, and pertinent information useful in following the progress of the call. The table is also an aid in localizing the area in which circuit troubles may be found. By giving a cross reference to the operational sketches, functional schematics and the sequence charts the table is useful when analyzing trouble recorder cards.

2. LINE RELAY OPERATION (OS 701-1, FS1, 101, 102, SD-26030)

2.01 Each line has an L- (line) relay which is located on the line link frame and each relay is associated with a vertical on a line switch. A variety of basic and supplementary frame sizes are available so that the number of lines (L relays) may be from 190 to 590 in 50 line increments, the remaining ten line switch verticals being used for no-test purposes.

2.02 Several of the sizes employ split frames, an arrangement not used on the replaced "U" type equipments. Split frames accommodate line switches associated with two adjacent line link frames. On the split supplementary frames the lower five switches are associated with the frame to the left and the upper five switches are associated with the frame to the right. On the 190 line basic frame the lower five switches are associated with that frame and the upper five switches are associated with a basic frame having only combined line and junctor switches.

3. THE LINE LINK FRAME (FS 101, 102, SD-26030)

- 3.01 For purposes of calling line identification, the line link frame is divided into horizontal groups, vertical groups, and vertical files.
- 3.02 On nonsplit frames a horizontal group consists of all the lines on all the switches of the same number, and are the switches whose horizontals are multiplied. Switches number from 0 to 9 from the bottom of the frame up. On split frames, the horizontals on each switch are also split so that half of the verticals are in one horizontal group and the other half in another. Here the left half of each group of five switches are numbered 0-4 and the right half 5-9.
- 3.03 Also on nonsplit frames a vertical file consists of ten verticals, one in each of the ten horizontal groups and in the same position on each switch. Five successive vertical files comprise a vertical group except in vertical group 2 where the first file is used for no-test purposes. Vertical groups are numbered 0-11. On split frames a vertical file consists of five verticals on the left half of the upper or lower five switches, that is in horizontal groups 0-4 and five verticals in corresponding positions on the right half of the upper or lower five switches, that is in horizontal 5-9. Vertical groups on the split frames follow the same pattern, the five 10 vertical switches having one vertical group and the 20 vertical switches having two vertical groups.

4. VERTICAL GROUP START RELAY OPERATION (OS 701, FS1-SD-26029, FS2-SD-26030)

- 4.01 The L- relays connected to one line group have contacts multiplied together and connected to a 536-ohm resistor. The resistors for all of the line groups in the vertical group connect to the VGS- (vertical group start) relay. Hence, any L- relay in the vertical group operates the VGS- relay (one VGS- per vertical group). A line group consists of five verticals, line hold magnets and associated equipment common to one vertical group and one horizontal group. These line groups are numbered 0-11 according to the vertical group in which they appear and the line relays and associated hold magnets in each line group are numbered 0-4.
- 4.02 In each connector the marker start relay circuit for each marker is brought out to an MS- terminal so that any marker may be connected as first choice. There are two start circuits in each connector which are brought through the connector control and thence to MSA and MSB terminals. These terminals are cross-connected to the MS- terminals of different markers giving each connector two choices. The VGS- relay connects battery through resistances "STA" and "STB" to the two marker connector start circuits. One or the other of these start circuits is closed through depending on whether relay Z in the connector control circuit is operated or normal, the position of the Z being changed on alternate calls. Assuming Z normal, VGS- connects battery through resistance STA, through control relays TC, Z, TRS, TRL, and TR relays to the MSA terminal. This terminal is cross-connected to an MS- terminal and determines which marker is preferred. This circuit is known as the "A" start circuit and is sometimes referred to simply as STA. A "B" start circuit or STB is similarly closed when Z is operated from battery through the STB resistance,

through control relays TC, Z, TRS, TRL and TR relays to the MSB terminal. This terminal is also cross-connected to an MS- terminal and determines which marker is preferred by the "B" start circuit. Only one of these leads is required on a connector usage. The connector control determines which start lead is to be used on a call, using the leads alternately, or in case of delay or trouble, shifting to the alternate choice. By this means a connector is always sure of being connected to a marker and the use of markers can be spread among the connectors to obtain a reasonably equal distribution of load.

5. THE LINE LINK MARKER CONNECTOR

5.01 The line link marker connector connects the leads necessary for a dial tone connection from a line link frame to a marker. Each line, line link and marker connector control circuit is provided with a line link marker connector circuit and a preference control circuit per marker. The line link marker connector circuit is equipped with one set of multicontact relays per marker. The number of leads to be connected by this circuit requires the use of two 30 contact wire-spring multicontact relays. The multicontact connector relay that is common to the line link frame requesting service and to the chosen marker is operated on marker seizure and is controlled by the preference control circuit.

5.02 There is an MS relay per marker per connector and when this relay operates, in response to a bid by a line link circuit for a marker it causes the connector relays to operate which will close all the necessary leads between the marker and line link frame.

5.03 The cabling of the leads connected by these relays is shown in Fig. 4. The leads are cabled from the line link frame to a terminal strip on the marker connector frame. Then they are multiplied with bare wire horizontal strapping (protected by plastic guards) to the armatures of the MA and MB connector relays serving the line link frame. The contacts of these relays are cable-multiplied to the relays - in other connectors - common to each marker, and then to the markers.

6. RELAY CHAIN CIRCUITS IN THE MARKER CONNECTORS (OS 701-1, FS2-SD-26029, FS28)

6.01 In each marker connector there is a preference control circuit consisting of a marker start relay MS and marker busy relay CB for each marker. It is the purpose of these relays to give each connector access to the first idle marker in the group depending on the point of connector access and to make that marker busy to all other connectors; to operate connector relays which will close all the necessary leads between the marker and the circuit requiring service; and by means of cross-connections in the markers to vary the order of preference of connectors for markers. Two relay chain circuits are used to choose a marker:

- (a) A CB- (marker busy) relay chain circuit per connector with one relay per marker in the group of markers serving the connectors. This chain determines which marker is used.

(b) An MS- (marker start) relay chain circuit per marker in the group serving the marker connectors, with one relay per connector. This circuit determines which connector seizes the marker.

6.02 A connector's preference is determined by its position in the MS- relay chain. The connector whose MS- relays are cross-connected directly to the MAK-ST and MCK-ST punchings in the markers has the highest preference. These connections give the marker connector first access to the operating grounds for its connector relays.

6.03 In dial tone markers, only line link frames are competing through MS- relay chains for markers. However, in completing markers, originating and incoming registers are competing for markers through the same MS- relay chains. The preference arrangement for marker connectors when used with completing markers gives highest preference to the originating register marker connectors.

6.04 An MS- cross-connection punching is provided per CB- relay. Punchings MSA and MSB for each connector are cross-connected to two of these MS- punchings. A marker associated with an MS- punching connected to an MSA or MSB punching is a first choice marker for the line link frame from which the start lead originates. Since there are two start leads, each frame has two first choice markers. The start lead that is connected through the marker connector control circuit determines which of these two markers is the first choice marker on a particular usage. The arrangement of the cross connection is such that each marker is first choice for about the same number of line link frames.

6.05 The particular start lead that is connected through the marker connector control circuit applies resistance battery to the punching to which it is connected. If the marker associated with this punching is busy serving another connector, relay CB- is operated. Resistance battery is then passed to the next CB- relay in the chain. Assume that the resistance battery is finally connected to a released CB- relay associated with an idle marker. This battery then operates and locks relay MS- (in preference control circuit) associated with the idle marker.

6.06 The operation of relay MS- operates relays MA and MB (line link marker connector), thereby seizing the marker. The operation of relay MA shunts relay CB- in the seizing preference control circuit associated with the seized marker. Relay MA operates relays MCB- (marker connector busy) in the marker. These relays apply ground to all of the CB- relays associated with the marker and operate all but the shunted one in the seizing connector. Relay MS- in operating also releases the marker connector check relays, MAK, MCK, and MSK in the marker. The release of any one of these relays operates relay, TM, which starts marker timing. Marker timing is described in CD-26001-01.

6.07 The connector is prevented from reverting to a more preferred marker by locking operated those CB- relays in the connector corresponding to busy markers at the time a seizure is attempted. The locking ground is provided immediately by relay TM (timing), and later by relay MA (marker connector).

It is connected in such a way that at least one CB- relay must be normal to enable the ground to lock those that are operated. This is necessary to prevent a call from blocking itself if a temporary all-markers-busy condition is encountered.

6.08 There is a time interval between the operation of relay MS- in the seizing preference control circuit and the operation of relays CB- in all of the other preference control circuits. During this interval other connectors may also operate MS- relays associated with the same marker. These MS- relays, however, would be in less preferred connectors than the first connector to succeed in operating its MS- relay. Because of the arrangement of the chain circuits controlling the operation of the MA and MB relays, the highest preference connector, with relay MS- operated, always succeeds in seizing the marker. The subsequent operation of CB- relays in the other connectors transfers their start leads to other markers, releasing their MS- relays associated with this matter.

6.09 On an attempt by two connectors to seize the same marker, the one with a faster operating MS- relay always succeeds. In order to prevent a particular connector from being served repeatedly while others are forced to wait, a system of traffic control is provided. Traffic control is described in CD-26029-01.

7. W AND Z RELAY COMBINATION FOR TRANSFERRING START LEADS (OS 701, FS4, SD-26029)

7.01 If only one start lead was provided, then, under light traffic conditions, a particular connector might seize the same marker for every usage. To prevent this, and also to reduce the possibility of circuit failure, two start leads are provided in each marker connector. By alternating the use of these start leads, two markers serve alternately as first choice markers, thereby providing more even wear on the marker connector relays. This transfer is accomplished with a W and Z relay combination. The operation and release of relay Z provides the necessary transfer.

7.02 In the following description, assume that relay TRS (transfer start) is normal. The functions of relay TRS are discussed in CD-26030-01.

7.03 The W and Z relay combination operates as follows:

(a) First Connector Usage

(1) Marker Seizure - Assume that relays MA, MB, W, and Z are normal.

Lead STA has continuity through relay Z, and lead STB is open. A marker is seized by the operation of relay MS- via the MSA MS cross connection. Relay MS- causes the operation of relays MA and MB. Relay MA operates relay MK which in turn operates relay W, which locks. At this time, ground is also applied to both sides of the Z relay to prevent its operation.

(2) Connector Release - The marker releases the connector by opening the battery path of relay MS-. Relay MS- causes the release of relays MA and MB. Relay MA releases relay MK which removes the ground that shunts relay Z. Relay Z operates from the locking ground of relay W, which remains operated. The operation of relay Z opens lead STA and closes STB, making it available for the next usage.

(b) Second Connector Usage

(1) Marker Seizure - Relays MA and MB are normal and relays W and Z are operated. A marker is seized by the operation of relay MS- via the MSB-MS cross connection. Relay MS- causes relays MA and MB to operate. The operation of relay MK, this time, shunts relay W, releasing it. Relay Z remains operated because relay W in releasing transfers the operating ground of relay Z from the locking ground of relay W to the ground furnished by relay MK.

(2) Connector Release - The marker again releases the connector by opening the battery path of relay MS-. The release of relay MK removes the Z relay holding ground, allowing it to release. Relay W remains released. The release of relay Z opens lead STB and closes lead STA making it available for the next usage.

(c) Subsequent Usages - The action described in (a) and (b) above continues.

8. MARKER CONTROL, CLASS, CHECK, AND ROUTE RELAY OPERATION (FS23-26)

8.01 Line link marker connector relays MA and MB, in addition to connecting a number of leads from the line link frame to the marker, also apply ground to various marker leads. Ground on one of these, the CKG (connector check ground) lead causes the operation of a number of marker relays. They in turn provide the batteries, grounds, and interconnections necessary for the marker to function.

8.02 Relay MS- may operate relay D (dial line frame), MF (multifrequency line frame), or MLF (mixed line frame) via the LF- to LFD, LF- to FLMF, or LF- to LFM cross connection. Relay D or MF indicates which type of originating register is required by all lines on the line link frame. Relay MLF indicates that some of the lines on the frame require one type of originating register and the rest require another. For the latter, relay D or MF is operated after vertical group identification via the VGR- to VGD or VGR- to VGMF cross connection.

8.03 At the present time No. 5 crossbar offices are equipped only with dial pulsing originating registers; hence the LF- to LFD cross connection is the only one used. Therefore, relay MS- in the line link marker connector always operates relay D. If in the future other types of originating registers are added, the other arrangements will be used.

8.04 Relay D starts the operations necessary for the identification of the calling line and for the selection of an available originating register.

9. CALLING LINE IDENTIFICATION AND SELECTION

A. General

9.01 Calling line identification and selection is made by the marker. It controls the connection of an originating register to a particular customer out of a number who may have originated calls at about the same time.

9.02 Calling line identification takes place in five steps:

- (1) Line link frame identification
- (2) Vertical group identification and selection
- (3) Horizontal group identification and selection
- (4) Vertical file identification and selection
- (5) Class-of-service identification

B. Line Link Frame Identification (FS10)

9.03 A line link frame is permanently connected to its line link marker connector. Three leads out of nine are grounded in the line link marker connector when relay MA operates. This serves to identify the line link frame number to the marker. The frame number may vary from 00 to 39. One-out-of-four leads identifies the first digit and two-out-of-five leads identify the second digit. Relays $FT \frac{1}{4}$ (frame tens) and $FU \frac{2}{5}$ (frame units) in the marker operate, through contacts of relay GT11, in response to these grounds. These relays operate one FTB- (frame tens-line link) and one FUT- (frame units test) relay. Relays FTB- and FUT- are used later in selecting a connecting path from the register to the calling line.

C. Two-out-of-five Transfer Circuit (FS6-13)

9.04 The two-out-of-five operation of the $FU \frac{2}{5}$ relays, previously mentioned, is an example of representing ten values with five relays. There are exactly ten combinations of two-out-of-five relays, or just enough to represent the ten values of a decimal digit. Instead of using arbitrary pairs of relays to represent the ten values, the five relays are designated 0, 1, 2, 4, 7, and a digit is represented by operating the two relays whose designations add up to its value. Thus digit one is represented by operating relays designated 0 and 1; digit 2 is represented by operating relays designated 0 and 2; and so forth. There is a single exception to this additive arrangement: digit 0 is represented by operating relays designated 4 and 7. This two-out-of-five additive code is useful for two reasons. First, only five relays are required to represent any one-of-ten values; and second, its pattern of two and only two elements out of five permits a check for correctness. This pattern is used in the registration check. The units digit ($FU \frac{2}{5}$) of the line link frame number is part of this check.

9.05 By the addition of one relay, a two-out-of-six additive code may be arranged to represent a maximum of 15 values. The sixth relay is designated 10. Digits 0 to 9 are represented by the same additive process as for two out of five, and digits 10 to 14 are represented by adding the designation 10 to designations 0, 1, 2, 7, and 4, in this order. Note that here again the process is additive with one exception; digit 13 is represented by operating relays designated 10 and 7. This two-out-of-six combination, limited to represent digits 0 to 14, is used for vertical group number registration.

D. Gating Control Circuit (FS6-7-8, 26)

9.06 The gating circuit, by its operation and release, controls the time during which one circuit can accept information from another. The gating circuit permits the marker to determine the particular vertical and horizontal groups and vertical files requesting service. Relay D operates the VGG- (vertical group gate) relay, the HGG (horizontal group gate) relay and the VFG (vertical file gate) relay in the marker. These relays connect test leads from the line link frame to test relays in the marker. As described later for the various parts of line identification, relays VGG-, HGG, and VFG in releasing disconnect the test leads after the marker test relays operate. This excludes later service requests and at the same time allows the marker to select one vertical group, one horizontal group, or one vertical file for service.

9.07 Before the marker can begin line identification, relay GK (gate check) must operate. This verifies that the line link marker connector is still attached and that relays VGG-, HGG, and VFG have operated.

E. Junctor Sequence Walking Circuit (FS15)

9.08 The marker provides a walking circuit for equalizing preference for various marker selections and to safeguard service by shifting the entrance point of preference circuits. Circuit functions using the walking circuit are:

- (a) Vertical groups (FS6)
- (b) Horizontal groups (FS7)
- (c) Vertical files (FS8)
- (d) Trunks (FS4 and 5)
- (e) Junctor Group and pattern (FS16-18)

9.09 The sequence circuit is arranged to advance one step each time the marker releases from a call. Assume that the marker is idle with one of its even numbered JSQ- and JLO relay operated. When the marker is seized the operation of relay LLC2 operates relay JSO. This provides a path to operate the next odd numbered JSQ- relay when relay LLC2 releases at the end of the call. The odd numbered JSQ- relay operates relay JLE, releasing the even numbered JSQ- relay which in turn releases relays JLO and JSO. Relay JSQ- (odd) and relay JLE are now operated and the same process occurs in operating an even numbered JSQ- relay on the next marker release.

9.10 Relays JSQ0-5 provide a six step sequence control circuit. A twelve step circuit can be obtained with relays SQ0 and SQ1 in either an operated or released condition. When these relays are released, relay JSQ0 operates relay SQ0 which locks to the released JSQ0 relay. Relay JSQ2 operates relay SQ1 which locks to the released JSQ2 relay, thus providing six steps. Relays SQ0 and SQ1 operated, provide the other six steps. In this case relay JSQ0 releases relay SQ0 and relay JSQ2 releases relay SQ1.

9.11 Slow release relay SQA is a check to see that the circuit advances properly. Failure of relays JS0, JSE, JLO and JLE to operate will operate relay SQA. Relay SQA also operates relay JSQ0 to start the sequence circuit when battery is first applied.

F. Vertical Group Identification and Selection (FS6-26)

9.12 Relay MA extends a maximum of twelve VGT- (vertical group test) leads from the JGS- relays in the line link frame to the marker. For a marker seizure by the line link frame at least one VGS- relay must be operated. Hence, one or more VGT- leads are grounded. These leads pass through the contacts of the VGG- relays to relays VGT- (vertical group test). A VGT-relay operates for each operated VGS- relay in the line link frame. The operation of one or more VGT- relays operates relay VGR (vertical group release). Relay VGR operates relay VTK (vertical group test check).

9.13 The operation of relay VTK connects relay OC1 (originating call - start lead A or B) in series with relay MS-. This places the marker connector under control of the marker. Relay OC1 operates relay OC (originating call).

9.14 Relay VTK operated also releases relays VGG-, thus releasing all but one of the operated VGT- relays. Relay VTK1 (vertical group test check) operates and verifies that relays VGG- and all but one of the VGT- relays have released. This one VGT- relay remaining operated is held under control of one of the operated JSQ- (sequence) relays. The holding circuit is from ground on contacts of relay D to relay VGT2 and then through an operated JSQ-relay to the contact chain on the other VGT- relays. On each marker usage the ground is applied at a different point in the contact chain. The first operated VGT- relay in the chain is thereby locked and opens the ground to any others, allowing their release when VGG- releases. The connection of the VGT2 relay is made independent of the sequence relays, because it is to this vertical group that police, fire, and other emergency lines are connected.

G. Horizontal Group Identification and Selection (FS7) (FS106-SD-26030)

9.15 The VGT- relay that remains operated as a result of vertical group identification operates a corresponding VGA- (vertical group auxiliary) relay on the line link frame. This relay extends ten test leads (HGTO-9) from contacts of the line relays (LO-14) in the selected vertical group to the marker. An operated line relay or relays in any line group in the vertical

group apply direct ground to the corresponding test lead. Because of the multiple arrangement for operating relay VGS- (refer to Section 4), those test leads for line groups in which all of the line relays are released will have ground from the operated line relays in other line groups connected to them through two 536-ohm resistors in series. In the marker, the ten test leads terminate on HGT- (horizontal group test) relays which operate only in response to the direct grounds. One or more operated HGT- relays operate relay HGR (horizontal group release). Relay HGR in turn operates relay HTK (horizontal test check) which releases relay HGG. Just as for vertical group identification, the release of relay HGG releases all but the one HGT- relay that is locked under control of the JSQ- relays.

9.16 The successful release of all but one HGT- relay and of relay HGG is checked by the operation of relay HTK1 (horizontal group test check auxiliary).

H. Vertical File Identification and Selection (FS8) (FS106-SD-26030)

9.17 As a result of vertical and horizontal group identification, the marker has determined the line group containing the calling line. The marker must now identify the vertical file to determine which of these five lines is the calling line.

9.18 The selected VGT- and HGT- relays operate relays VGB- (vertical group auxiliary) and HG(A, B)- (horizontal group), respectively, on the line link frame when it is seized. The operation of relay HG(A, B)- is checked by the operation of relay HGK (horizontal group check) in the marker. The combination of one VGB- and one HG(A, B)- relay, operated in the line link frame, operates relay LG- (line group connector) corresponding to the line group common to the selected vertical and horizontal groups. This extends a group of five leads (VFT-) from the contacts of the line relays in the group through contacts of relays VFG in the marker to the VFT- (vertical file test) relays. The operation is the same as for vertical and horizontal group identification. The operation of one or more VFT- relays operates relay FR (vertical file release). This releases relay VFG. All but one VFT- relay are thereby released, and FTK1 (vertical file test check) operates to indicate that VFG is released and only one VFT- is operated.

I. Marker Supervision During Line Identification and Selection (FS23)

9.19 While line identification is in progress, the marker maintains constant supervision over its selections, namely, the vertical group, horizontal group, and vertical file. Withdrawal of demands for dial tone during these selections will result in marker release.

9.20 On any stage of line identification, the release of relays VGG1, VGG2, HGG, or VFG releases all but one VGT-, HGT-, or VFT- relay. The test check relays VTK and VTK1, HTK and HTK1, and FTK1 are thereby operated. Relay VGR, HGR, or FR is held by the ground on the line link frame that originally operated the selected test relay. If at any stage of line identification this ground is removed (abandoned call), the VGR, HGR, or FR relay releases. This condition, together with the operated test check relays, operates relays DIS1 and DIS2 (marker disconnect), causing the marker to disconnect.

J. Class-of-service Identification (OS 705-1, (FS6-12)

9.21 To properly charge the calling subscriber for the call, it is necessary to identify the class of service. This information is required so that subscribers being served under different charging plans may be correctly charged. To accomplish this, as many as sixty classes of service can be provided.

9.22 With the exception of the no-test vertical file, all the vertical files on the line link frame are available for line assignment and may be assigned to any of sixty classes of service. They may be grouped on the line link frame in any manner subject to two limitations.

- (a) All lines located in the same vertical file within the same vertical group must have the same class of service.
- (b) The assignment of a class of service number for a particular class of service must be the same for both the A and B groups.

9.23 On the line link frame there is a V-punching for each vertical file, and a CS- punching for each class of service. The V- punchings are cross-connected to the appropriate CS- punchings in accordance with the class of service.

9.24 When an office requires more than thirty class of service indications they are divided into two groups of thirty classes on each line link frame, group A and group B. On the line link frame there is a VG- punching for each vertical group, a CA punching and a CB punching. The CA and CB punchings are connected in series to the CGA and CGB relays respectively in the marker through the line link connector circuit. When the lines in a particular vertical group belong to the first group of 30 classes or group A the VG- punching is cross-connected to the CA punching, this causes the VGB- relay in line link and marker connector control circuit and the CGA relay in the marker to operate in series. When the lines in a particular vertical group belong to the second group of 30 classes or group B the VG- punching is cross-connected to the CB punching, this causes the VCA relay in the line link and marker connector control circuit and the CGB relay in the marker to operate in series. The operation of relay FTKL, together with an operated VGB- relay for the vertical group, and an operated VFT- relay for the vertical file, operates the marker CS- relay that corresponds to the class of service of the selected vertical file.

10. TRUNK LINK FRAME SELECTION, PREFERENCE, AND SEIZURE (FS1-2-3-26, OS 702-1)

A. General

10.01 When the marker is directed to establish a dialing connection, it tests for an idle trunk link frame that has access to one or more idle originating registers. An idle trunk link frame is one to which another marker is not connected at this time, although many of the trunks and registers which

have appearances on this frame may be busy serving other calls. When an idle trunk link frame is found, the marker operates the set of trunk link connector relays common to itself and the frame, thereby seizing it. A typical multiple arrangement of the trunk link connector frames is shown in Fig. 5.

B. Testing for an Idle Trunk Link Frame (FS1, OS 702-1)

10.02 Relay D or MF operates relays BCO and BC10 which are the busy cut in relays. Relay BCO extends the windings of the frame busy FBO to 9 relays and BC10 extends the windings of the frame busy FB10 to 19 relays to their associated trunk link connector over the FB10-19 leads. If the trunk link connector is busy the corresponding test lead is grounded and the associated FB- relay will be operated. Idle trunk link frames are indicated by normal FB- relays.

C. Testing for an Idle Originating Register (FS1-2-26, OS 702-1)

10.03 Relay D operates the FCDO and FCD10 (frame connector) relays and the MF operates the FCMO and FCM10 (frame connector) relays associated with originating register test leads. When the FCDO and FCD10 or FCMO and FCM10 relays operate they extend test leads (one per trunk link frame) from the marker to the trunk link frames. These leads are cross-connected in the frame to test leads from all of the originating registers having appearances on the frame. If at least one register is idle the test lead is grounded, thereby operating the corresponding FTC- (frame test common) relay in the marker. If no registers are idle, the lead is not grounded and the corresponding FTC- relay remains released. Relay FTCK (frame test check) operates to indicate that one or more FTC- relays are operated.

D. Trunk Link Frame Preference

10.04 Since it is undesirable for the same trunk link frame to be first choice for the same marker on each usage, a rotating preference system is used. On the previous marker usage, one of the FMO-4 (frame memory) and FMG- (Frame Memory group) relays that correspond to the trunk link frame used were operated and held until this marker usage. If none were operated, such as after initial application of power, the FMO and FMGO would operate when power was applied. The FMO operates through a chain of break contacts on the other FM relays and released RYC relay. The FMGO operates through break contact of FMG5 and released RYC relay.

10.05 On this usage, the operated D or MF relay together with the held FM- and FMG- relays operate the FMK (frame memory check) relay, this in turn will operate the FMG (frame memory guard) relay. Relays FMK and FMG indicate that an FM- and an FMG- relay is operated.

10.06 The operating ground for relay FS- (frame selection) is supplied through the operated FTC- relay corresponding to a trunk link frame with an idle originating register and the contacts of the operated FM- and FMG- relays associated with the previous trunk link frame usage. If relay FTC- is released, indicating no idle registers, the ground is passed to the next FTC- relay.

If relay FTC- is operated, indicating idle registers, but relay FB- is operated, indicating a busy frame, the ground is still passed to the next FTC- relay. If the FTC- relay is operated and the FB- relay that corresponds to the same trunk link frame is released, the ground is then applied to the FS- relay, operating it.

E. Trunk Link Frame Seizure (FS2-3-4, SD-26039)(FS1, SD-26033)(FS1-3)(OS 702-1)

10.07 Each trunk link frame has a trunk link connector and a preference control and make busy circuit associated with it. The marker preference relays are contained in the preference control circuit and the marker connector relays in the trunk link connector circuit.

10.08 In each preference control circuit there is one MP- (marker preference) relay associated with each marker. The operation of the FS- relay extends battery over the ST- lead to the MP- relay which operates if no other marker closer to ground in the chain attempts to operate its MP- relay. The MP- relay locks to ground on its own contacts.

10.09 The operation of the MP- relay causes the operation of the M relay in the trunk link connector circuit under control of a chain circuit through normal MP- relays in lower preference circuits unless it is the lowest preference circuit. Relay M operates the MA1,2, MB1,2, MC1,2, and MD1,2 relays in the trunk link connector. TFK1 and TFK2 (trunk frame check) operate to indicate the seizure of the trunk link frame.

F. Recycle of Frame Memory Preference (OS 702-1, FS1-2)

10.10 After the trunk link frame has been seized it will be necessary for the marker to reset the frame memory relays. The operation of relay TFK1 removes the locking ground from relays FM- and FMG- held from the previous usage, thereby allowing them to release. The release of relays FM- and FMG- release relay FMK which releases relay FMG. The release of relay FMG, together with the operated relay FS- on this usage, operates the FM- relay that corresponds to the trunk link frame being used. Relay FMK reoperates. Because relay TFK1 is operated, relay FML (frame memory lock) operates and relay FMG remains nonoperated. The operation of relay FML releases relays BCO and BC10, opening the trunk link frame test leads and releasing the operated FB- relays.

Note: On incoming and pulse conversion calls the frame memory is not recycled. This is because the seized trunk link frame on these calls is predetermined by the trunk location instead of being selected by the marker.

11. LINE LINK FRAME SEIZURE (OS 703-1) (FS1-SD-26031) (FS11)(FS2-4-SD-26039)

11.01 Each line link frame has a marker connector control circuit, a marker connector circuit, a line link connector circuit and a preference control and make busy circuit associated with it. The preference control circuit is used by the marker to gain access to the line link frame and its purpose is to permit only one marker to have access to a particular frame at a time.

11.02 Following trunk link frame and connector seizure, the marker seizes the line link frame (which has identified itself through its marker connector) in competition with other markers which may be connecting or waiting to connect calls to the line link frame through the preference control circuit.

11.03 The operation of the marker TFK1 relay indicating trunk link frame seizure, connects battery to the LFS lead through the associated line link marker connector circuit, the start lead ST- to the preference control circuit. This start lead, together with start leads from all other markers, connects to the MP- (marker preference) relays arranged in a lockout chain circuit.

11.04 The first MP- relay to operate opens the ground path for more preferred MP- relays, and at the same time operates its own line link connector relay MA1. The break-make chain on the MP relays prevents the operation of more than one MA1 relay at one time. The MA1 relay operates relay LFK (line frame check) to indicate the seizure of the frame.

11.05 During this time, less preferred markers are able to operate their MP- relays in the chain. These markers are later served in preference order as previously served markers release.

11.06 This permits vertical file identification to proceed (described in Section 9, H).

12. ORIGINATING REGISTER SELECTION (OS 704-1)(FS1, FS5)(FS14, SD-26040)

A. Trunk Blocks and Trunk Groups

12.01 The trunk link frame has 160 outlets to which trunks and originating registers may be assigned. The trunks that have their connection to the marker predetermined are assigned to 40 of these outlets. For example, an incoming trunk from another office, when used on a call, is identified to the marker; and the marker must connect to this particular trunk to assist the call. The remaining outlets (120) are assigned to originating registers and those trunks which the marker may select. For example, the marker may use any idle outgoing trunk of the proper type (AMA, flat rate, coin, etc.) that connects to the desired completing office. By the same token, any idle originating register is suitable to complete a dialing connection.

12.02 These 120 outlets or appearances are assigned to trunk blocks (TBO-5) which consist of twenty trunks and/or registers. All of the originating registers (10 maximum) appearing on one trunk link frame are in one trunk block. In addition to the originating registers, one or more types of trunks may be assigned to this same trunk block. In order to differentiate these from each other, and from the registers, a further subdivision of twenty test groups (TGO-19) is provided. Originating registers and each trunk of a group, within one trunk block, are assigned to different test groups; therefore, the selection of one trunk block and one test group differently selects the originating register or desired trunk.

12.03 The trunks connect to the horizontals or levels on the trunk switches.

There are two trunk appearances per level for levels 2 to 9 on the 10 trunk switches. The two appearances per level are obtained by using a 6-wire switch and operating a T0 or T1 select magnet (Position 0 or 1 respectively) in addition to the T select magnet associated with the level on which the trunk appears. The T0 or T1 select magnet controls crosspoints which connect the link to one or the other of two vertical multiples each consisting of tip, ring and sleeve. The trunk select magnet T- controls crosspoints which connect two horizontal tip, ring and sleeve multiples (corresponding to two trunk appearances) to the two vertical multiples but, as was just explained, only one vertical multiple is connected to a link. In this manner we have effectively obtained 16 trunk appearances per switch. Appearances connected by a T0 select magnet are called A appearances and those by a T1 select magnet, B appearances. Associated with each A appearance is an FA relay and with each B appearance an FB relay. These relays are effectively trunk connector relays and are operated by the F relay in the trunk. Intraoffice trunks require two appearances on the same trunk link frame and on the same level but on different switches. The calling end is on an A appearance and the called end is on a B appearance. The B appearance is on a switch one higher in number than the one containing the A appearance. Incoming trunks and other trunks requiring ringing are on B appearances. Registers, outgoing trunks and other trunks handling outgoing calls may be on either A or B appearances.

12.04 Economies were made for the dial tone marker circuit by assigning all registers to trunk block 0 with trunk group 0 for dial pulse originating registers and trunk group 1 for multifrequency originating registers. Also, only the A appearance of the trunk switch are used for originating registers. With these restrictions all originating registers are assigned to level 2, A appearance on the trunk switches, while the trunk switch number, 0-9, are associated with the BTO-9 leads.

B. Selection of Register

12.05 Before selecting the trunk link frame the marker has determined that one or more originating registers are available for use. Now it is necessary to determine which are idle.

12.06 Following seizure of the trunk link frame, the marker determines which originating registers on that frame are idle, and then selects an idle one.

12.07 Battery from the marker operates relay TBO (trunk block) in the trunk link circuit when the connector cut through relays operate. The operation of relay TBO is checked by relay TEK (trunk block check) in the marker.

12.08 Relays TSEL₂ are operated by relay TLC. Ground on the BTO-9 leads, when the connector cut through and TEO relays in the trunk link circuits operate, will operate one or more TTO-4 relays if relay TSE2 is operated. Since relays TTO-4 are double wound, their operation calls for an odd and even preference lockout circuit to identify which BT lead is grounded.

12.09 The operation of relays TSE1, TBK, MAK 1, and one JSQO-5 and TTO-4 relay operates one TSO-4 (trunk select) relay. Relay TS- locks to relay TLC and releases relays TSE1,2 which release all operated TTO-4 relays. The JSQO-5 relays are used for even distribution and their operation is described in Section 9E.

12.10 The released TSE1 relay and operated TSO-4 relay extends the BT lead to the OTS and ETS (odd and even trunk selection) relays. If either an even or odd BT lead is grounded, it operates its corresponding trunk selection relay. If both an even and odd BT lead is grounded, relay SQ1 (sequence) determines the selection of the proper trunk selection relay.

12.11 Relays ETS and OTS have 10-ohm windings to operate them and 200-ohm windings to release them. When both windings are energized the 200-ohm winding holds the relay released. A released SQ1 relay thus operates relay ETS and disables relay OTS. Relay OTS operates and ETS releases when relay SQ1 is operated.

12.12 Relay F in the originating register would not operate in series with the high resistance TTO-4 relays. Relays ETS or OTS are lower in resistance than relays TTO-4 and since they are now in series with relay F they allow it to operate. Relay F operates relays FLA and FLB in the register. The group of leads over which the marker passes calling line identification to the register are thereby connected to the trunk link frame.

13. CHANNEL SELECTION

A. General

13.01 After calling line identification and originating register seizure the marker selects an idle channel (path connecting a line to a register). A channel consists of a line link, a junctor, and a trunk link. Line identification fixes the line link frame termination of the channel, and the originating register location fixes the trunk link frame termination.

13.02 There are at least half as many trunk link frames as line link frames. Each line link frame terminates 100 junctors and each trunk link frame terminates 200 junctors. Depending on office size, there are ten to fifty junctors common to a line link and a trunk link frame. They are divided into subgroups; the first containing ten and the others ten or few junctors. For offices with more than twenty line link frames, extension trunk link frames are provided. They allow a pair of trunk link frames to share a group of junctors, thereby maintaining at least ten junctors available for connections to each line link frame.

13.03 In selecting a channel, the marker tests:

- (a) the ten line links on the line switch connecting to the calling line
- (b) a subgroup of junctors to the trunk link frame connecting to the register
- (c) the ten trunk links from these junctors to the trunk switch connecting to the register

By testing the ten channels formed by these elements, the marker selects an idle channel for the connection.

13.04 If no channel is found, the marker steps the junctor subgroup selection and again makes channel test. If this fails or if there is only one subgroup, another register is seized and channel selection is again attempted (marker recycle).

13.05 Selecting or marking the entire connecting path is unique to crossbar systems. It distinguishes them from hunting systems in which idle elements of the connecting path are tested and seized in succession as the connection progresses from a calling line to a trunk.

B. Junctor Subgroup Selection (OS 706-1, OS 707-1)(FS14, FS15, FS16, FS18, FS19, FS21)

13.06 The junctor subgroup to be tested depends on the frames to be connected, the junctor distribution, and the junctor sequence circuit setting.

13.07 As stated in 13.02, the number of juncctors in a junctor group (particular trunk link to particular line link frame) may vary from a maximum of fifty juncctors to a minimum of ten juncctors. When the number of juncctors in a junctor group is in excess of ten, the junctor group is divided into subgroups. Since a subgroup may contain from one to ten juncctors, the number of junctor subgroups may vary from a maximum of five to a minimum of one.

13.08 The STP1 (stepping) relay and the JSQO-5 (junctor sequence) relays control junctor subgroup selection for the first step. When more than one subgroup is provided, the second step in subgroup selection is controlled by the STP2 relay and the JSQO-5 relays. The first selected subgroup always contains a full complement of ten juncctors. The second selected subgroup may contain from one to ten juncctors.

13.09 When the marker selects a subgroup which contains the full complement of ten juncctors, the PNR (pattern normal) relay is operated. However, when the selected junctor subgroup consists of less than a full group of ten juncctors one of the junctor pattern tens digit number PA, PB or PC relays and one of junctor pattern units digit PO-0 relays will be operated to identify the junctor subgroup pattern and to identify the juncctors within the junctor subgroup which are available.

13.10 The number of juncctors within a junctor subgroup will vary from a maximum of ten juncctors to a minimum of one junctor depending upon the office size and the selected junctor subgroups. The marker is equipped to simultaneously test ten separate channels therefore the marker must determine those channels which are incomplete because of nonexistent associated juncctors within the selected junctor subgroup. The marker must then consider these incomplete channels unavailable so that the marker will not select one of these incomplete channels for service.

13.11 As outlined in 13.03, the marker tests the line links, trunk links, and junctors to select an idle channel. The test leads for 20 junctors, which are associated with a particular horizontal level on the trunk link frame junctor switches, are under control of a junctor connector relay JCO-19. Of the twenty junctors, ten are connected to the left half and ten to the right half of the switches. The left half is controlled by relay L (left) and the right half by relay R (right). In single frame or paired frame offices the JCO-9 relays control horizontal levels 0 through 9 on the regular junctor switches. In paired frame offices, the JC10-19 relays control horizontal levels 0 through 9 on the extension junctor switches. When there are extension frames, relays EL (extension left) and ER (extension right) are also provided.

13.12 Each junctor in the subgroup has a J-test lead. By operating one JC-relay and either the L or R relay, the marker connects these leads to the CHTO-9 (channel test) relays.

13.13 Relay R operates when relay JGO or JG3 and an odd-numbered FUT- relay are operated, or when relay JG1, 2, or 4, and an even-numbered FUT- relay are operated. Relay L operates from JGO or JG3 and an even FUT- or JG1, 2, or 4 and an odd FUT- relay.

C. Selection of the Group of Line Links (FS19)

13.14 The operation of relay HG(A,B)- in the line, line link, and marker connector control circuit, as a result of horizontal group identification, connects the sleeves of the ten line links on the calling line switch to the windings of the CHTO-9 relays in the marker. This operates the CHTO-9 relays that correspond to busy line links.

D. Selection of the Group of Trunk Links (FS1, SD-26032-01)(FS19)

13.15 The operated F relay in the originating register operates one of the FA02-FA92 (A appearance trunk connector) relays in the trunk link circuit. This operated FA02-FA92 relay operates the LV2 (level 2) relay. Battery from the marker on the ALC lead operates the LC- (link connector) relay in the trunk link circuit. The operated LC- relay, together with the L or R relay, extends the ten trunk links to be tested to the CHTO-9 relays in the marker; an operated CHTO-9 relay in this case indicates a busy trunk link.

E. Test Check (OS 708-1, FS21)

13.16 Before the marker proceeds with channel selection it first determines whether the necessary preliminary functions were performed. These functions are checked by the operation of relay TK (test check).

13.17 The following relays must be operated for this check to be successful:

<u>Relay</u>	<u>Functional Meaning</u>	<u>Indication</u>
FAK	(frame A appearance check)	Relay LV2 and an FA02-92 relay are operated

<u>Relay</u>	<u>Functional Meaning</u>	<u>Indication</u>
RK or LK	(right- or left-half frame check)	Relay R or L is operated
HGK	(Horizontal group check)	Line link sleeves are closed through to the marker
LCK	(trunk link connec- tor check)	Trunk link sleeves are closed through to the marker
JCK	(juncator connector check)	Juncator sleeves are closed through to the marker
TCHK	(test channel check)	One or more TCH- relays are operated

F. Channel Test and Selection (OS 706-1, 707-1, 708-1, FS19)

13.18 The channel test CHTO-9 relays are provided to test the sleeve leads associated with the selected group of junctors for a busy indication. Ground on any of the three leads associated with a particular CHT- relay indicates a busy channel and will operate the relay. The CHTO-9 relays will simultaneously test these three leads (line link, trunk link and junctors) to determine if the associated channel is busy. Therefore the operation of a CHT- relay indicates that at least one of the three linkages that make up the channel are busy. The operation of the CHT- relay prevents the marker from selecting that channel for this call.

13.19 The windings of the CHTO-9 relays are connected to the sleeve circuit through the associated LO-9, JO-9, and TO-9 diodes, LO-9, JO-9, and TO-9 resistances through the back contacts of the CHO-9 relays and to the respective LLO-9, JO-9 and LHO-9 leads.

13.20 The diodes are used to prevent the high negative surges produced by the release of hold magnets, which had been associated with busy linkages, from reaching the winding of the CHTO-9 relays. A voltage divider effect is provided by the LO-9, JO-9, and TO-9 resistances. The LO-9, JO-9, and TO-9 capacitors reduce the transient voltages.

13.21 When the marker is normal a standing cross test is made on these leads by the XCH relay. During this period the negative side of the windings of the CHTO-9 relays is connected to the XCH relay. When the marker is off-normal the STX relay shifts the windings to battery potential.

13.22 It is necessary to delay the action of the channel selection CH- relay until all the CHT- relays have had sufficient time in which to operate. This delay function is performed by the operate times of the TK and DTK which operates from the TK when the marker has possession of both the line link marker connector and the line, line link and marker connector control circuits.

After this delay one preferred channel selection relay, associated with a released CHT- relay, will be operated. This selects the connecting path associated with an idle line link, trunk link and junctor. The operated CH- relay operates relay CHA to indicate that a channel has been selected.

G. Junctor Distribution (OS 707-1, FS14, FS15, FS16)

13.23 Office size determines junctor distribution. When junctor distribution is uniform for all frames, the operation of relay TLC (trunk link control) operates one of the 2TLF-1OTLF relays via the SZD to SZ- cross connection. Relay TLC also operates relay STF (single-trunk link frame) or relay PR (paired-trunk link frame) via the SPF to SF or SPF to PR cross connection. The 2TLF-1OTLF relay indicates how many trunk link frames or pairs of frames are in the office, therefore, the junctor distribution is indicated. The STF or PR relay indicates single frames or pairs of frames. In addition to these relays, auxiliary indication of office size is given by relays 2OF (maximum of 20 line link frames); 4OF (21 to 40 line link frames); 7Q (7 quad) for 7 trunk frames or pairs of frames; or RQ (regular quad) for 6, 8 or 9 trunk link frames or pairs.

13.24 During changes in office size, the trunk link frames are arranged for different junctor distribution. As the work progresses some trunk link frames will have junctor distributions corresponding to the new office size, some to an intermediate size, and some to the original size. For example: suppose that the 10 line link - 5 trunk link frame office is to be expanded to the 12 - 6 office. In the 5-trunk link frame size the junctor groups contain twenty juncctors, ten in each subgroup. The change in distribution resulting from the addition requires the removal of some of the juncctors from the second subgroup to form new junctor groups to the added line link frames. During this work the subgroup is unusable. To prevent the selection of this subgroup, the trunk link frame is temporarily arranged to indicate to the marker that it has the same junctor distribution as a trunk link frame in an office with ten trunk link frames; namely, only one subgroup of ten juncctors. After completion of work on this frame, it is then arranged to indicate its new distribution - for an office with six trunk link frames.

13.25 For an office being expanded from 5 to 6-10 trunk link frames, relay 1OTLF is used as an intermediate office-size relay; for expansion from 3 to 4 or 5 frames, relay 5TLF is used; and for expansion from 2 to 3 frames, relay 2TLF-3TLF is used. It should be noted that the 2TLF-3TLF relay is used only as an intermediate office-size relay.

13.26 During transition, the 2TLF-1OTLF relays are operated via cross connections SZA, SZB, and SZC to SZ- in the marker and G to SZA, SZB, and SZC in the individual trunk link frames; punching SZD is not used during this period. When the transition involves adding extension trunk link frames to pair the frames, the G to SF or G to PR cross connection in the trunk link frame permits the operation of relays STF or PR in the marker until the changeover is complete.

14. FORWARDING CALLING LINE IDENTIFICATION AND CHANNEL NUMBER TO THE ORIGINATING REGISTER (FS8-13)(FS2-8-9-14, SD-26040)

14.01 When the originating register is seized, relay F operates, in turn operating the FLA and FLB (frame auxiliary) relays. After vertical file identification, relay FTK1 operates. Relays FLA, FLB, and FTK1 operate the GTL3, (ground transmitting leads auxiliary) relay. This permits the marker to operate relays in the register to record the calling line information and channel number. This information is used by the marker which is seized after dialing is completed.

14.02 The following table shows the register relays operated and the information passed.

<u>Register Relays Operated</u>	<u>Information Passed</u>
FT-	line link frame tens
FU $\frac{2}{5}$	line link frame units
VG $\frac{2}{5}$ or $\frac{2}{6}$	vertical group number
HG $\frac{2}{5}$	horizontal group number
VF-	vertical file number
CT-	class tens
CU $\frac{2}{5}$	class units
MAN (manual) 2P (2 party) CN (coin)	auxiliary class information
LL $\frac{2}{5}$	line link number (corresponds to channel number)

14.03 The RK1 and RK2 (registration check) relays in the marker operate to indicate that all of the marker registration relays have operated. To verify that the register is attached and that it can lock in the information passed, the RK3 (registration check) operates. This releases the GTL1, GTL2, and GTL3 relays (ground test relays). The grounds which operated the register and marker registration relays are thereby removed. These relays must be held operated by the originating register ON (off-normal) relay in order to maintain the registration. The release of any operated registration relay in the marker indicates that the corresponding register relay failed to operate or to lock operated.

15. SELECT AND HOLD MAGNET OPERATION (FS20, FS22)

15.01 Relay FAK operates trunk switch select magnets T2 and A through contacts of relays FA02-FA92 and LC-. Relay CH- corresponding to the selected channel operates select magnets J- on the trunk link frame, and L- and LJ- on the line link frame.

15.02 The operation of relay CHA at the end-of-channel selection starts the timed operation of the HMT (hold magnet timing) relay. This delayed operation is necessary to insure that the select magnets are operated and that any hold magnets for this channel are released from previous connections.

15.03 Relay HMT operates relay HMT1 (hold magnet timing auxiliary) which operates relay HMS1 (hold magnet start).

15.04 Since the operation of the hold magnets for light and heavy traffic is different, it is described separately.

Hold Magnet Operation - Light Traffic (OS 709, 710, FS19, FS20, FS24, SC 701-1)

15.05 During light traffic conditions, relay HMS1 extends battery from the line link frame junctor hold magnet J-, through the trunk link frame, and into the marker over the JO-9 leads. These leads are extended to the primary winding of the JXP (junctor crosspoint) relay. Hold magnets J- and T- on the trunk link frame are also operated by relay HMS1 over the LHO-9 leads.

15.06 Relays ILTA, SLA, and JXP1 operate to show that these hold magnets have operated. The operation of these relays, with relay HTR released and relay RK3 operated, operates relay LTR. Relay LTR is slow in operating to allow for completion of the false cross and ground test. If relay FCG (false cross and ground) remains released, relay LTR will operate relay LTRA which operates relay GLH. The operation of relays GLH and LTRA removes relay FCG from the tip and ring conductors. Relay, LTRA also operates the line link frame line switch hold magnet.

Hold Magnet Operation - Heavy Traffic (OS 709-1, FS20, SC 701-1)

15.07 Relay HTR operates during heavy traffic and operates relay DVO, this indicates that the hold magnets should be operated by dual voltage.

15.08 During the hold magnet timing interval the +130 volt battery will charge either one 4.32 MF or two 4.32 MF capacitors to +130 volts. When a hold magnet is to be operated, the +130 volts on the capacitor is extended from the marker to the winding of the hold magnet. The +130 volt charge on the capacitor will then be discharged through the hold magnet. The capacitor discharge current will operate the hold magnet more quickly. When the voltage across the capacitor drops to about -.5 volts the diode will become conducting and will supply the steady current flow to hold the hold magnet operated.

15.09 To decrease the time of operation of the crossbar switch hold magnets and of the marker holding time the hold magnets may be operated by the use of a momentarily applied dual voltage of 178 volts (130 + 48) instead of the usual 48 volts. In this case, when a hold magnet is to be operated, the marker will apply momentarily a voltage of +130 volts to the hold magnet winding. Since the other end of the hold magnet winding connects to -48 volts, this will give a total operating voltage of 178 volts which will operate the hold magnet in about one-third of the time required for 48-volt operation.

15.10 One side of the LH, JH, and TH capacitors are connected to ground through either the LXP or JXP relay or TXP lamp. When the CHA relay operates with the DVO relay operated, the +130 volt battery will charge the other side of the capacitors to +130 volts. The operation of the HMT1 relay will remove this charging circuit. While the capacitors are charging the LH, JH and TH diodes will have no effect. The false cross and ground test is eliminated during heavy traffic to reduce marker holding time.

16. CONTINUITY TEST (FS20-24, SC 701-1)

16.01 The continuity test is made from the marker, through the switching elements, to the calling line. It has two functions: first, to determine whether the connection is complete; and second, to determine when the last crosspoint (line switch) has closed. This latter function brings about a reduction in marker holding time. If it were not for this test, marker release would always have to be delayed for an interval equal to the slowest possible operating time of the crosspoints.

16.02 Basically, the test consists of connecting a grounded source of alternating voltage in series with a capacitor to one side of the line, and ground to the other side. The start gap of a cold-cathode tube is bridged across the capacitor. If the connecting path is continuous, the major portion of the applied voltage appears across the capacitor. This causes the tube to conduct, thereby indicating a successful test. If the path is open, a small amount of line capacitance completes the circuit, but the voltage across the tube gap is insufficient for conduction.

16.03 The operation of relay GLH, with relay RCTA (reverse continuity test) operated, connects ground to the tip lead and the applied voltage to the ring lead. The closure of the line switch hold magnet completes the path through the customer's telephone set (off-hook condition) or ringer (abandoned call). The voltage across capacitor CON2 builds up to the firing potential of tube CON, causing it to conduct. Current flow in the anode path operates relay CON (continuity test). This relay operates relay CON1, which locks and indicates that the continuity test has been successfully completed. A contact on relay CON1 grounds the start anode on tube CON allowing it to function as a cathode, thereby splitting the required anode current between it and the original cathode. This is a factor in prolonging the life of the tube. Relay GT1 (ground test) operates from relay CON1. Relay GT1 opens the anode path, making the tube nonconducting and releasing relay CON.

16.04 The closure of the line switch crosspoint releases relay LXP by placing the sleeve holding ground on its primary winding, thereby shunting it down. Relay LXPl operates relay RCTB (reverse continuity test auxiliary). Relay RCTB opens the operating path of the slow-release relay RCTA. If the continuity test is successful before RCTA releases, relay CON1 releases RCTB, reclosing the operating path of RCTA. The alternate operation and release of relay RCTA switches the alternating voltage to either the tip or ring lead.

16.05 As previously described, the continuity test can be successful through the closed switchhook path or, if the call is abandoned, through the telephone ringer. When a call is abandoned by the tip party on the 2-party line that has no ring party installed, the release of relay RCTB causes the continuity test to be successful through the tip ringer to ground. The continuity test must be successful on an abandoned call; otherwise, abandoned would cause continuity test failure and a consequent trouble record.

17. DOUBLE CONNECTION TEST (OS 710-1, FS20-23)

17.10 Double connection test is made to insure that the only ground holding the magnets connected to the channel sleeve is being provided by the marker making this connection. The operation of relay LXPl and JXPl transfers the holding ground for the sleeve circuit to the DCT (double connection test) relay. The holding ground is now provided through the DCT relay primary winding. The operation of relay DCT operates relay DCT1, which locks, and thereby records a successful double connection test. If there is another ground present on the sleeve, the DCT primary winding is short-circuited and the relay fails to operate.

18. TRANSFER OF SUPERVISION TO THE ORIGINATING REGISTER (FS1-2, SD-26032) (FS1-9, SD-26040)(FS1-4-9-11-12-19-20)

18.01 The operation of relay DCT1 removes the operating ground from the F relay in the selected register. Relay F releases, and releases the one operated FA02-FA92 relay in the trunk link circuit. The release of the one operated FA02-FA92 relay transfers the channel sleeve lead to a 10-ohm ground in the originating register. The release of the one operated FA02-FA92 relay also releases relay SL, and the 10-ohm register ground short-circuits the DCT primary winding releasing the relay. Relay DCT verifies that the selected channel is connected to the calling line.

18.02 The release of the one operated FA02-FA92 relay operates the L (line) relay in the originating register. Its path of operation extends through the TN coil, over the loop and back through the TN coil to ground. Relay L operates the SR (slow-release) relay which operates relay ON1. Relay ON1 closes the tone path to the tertiary winding of the TN coil, causing dial tone to be transmitted to the customer. However, when manual service is provided for the calling line, dial tone is unnecessary. Therefore, the operated MAN relay in the register opens the dial tone supply lead.

18.03 When the calling line is 2-party message-rate class or 2-party flat-rate class in offices arranged for AMA, the transmission of dial tone to the customer is delayed until the originating register determines which party on the line is originating the call. When the calling line identification is transferred to the register, relay 2P in the originating register operates and locks.

18.04 For lines having low-impedance ground (approximately 1000-ohm ground on tip party station), relay 2P operates relay TPA which connects relay TP (tip party) to the tip and ring of the calling line. If the line is grounded, indicating a tip party, relay TP operates and in turn operates relay TPI which locks.

18.05 When the F relay releases after the dial tone connection is set up, ground is removed from the TPT3 resistor. Capacitor TPT starts charging. After about 0.3 second the voltage across the capacitor is high enough to cause the TPT tube to conduct. Relay TPT (2-party test timer) operates and unlocks relay TPA. Relay TPA removes relay TP from the tip and ring and places relay L across the line. Relay L operates from the closed loop and causes dial tone to be transmitted to the customer as described in 18.02.

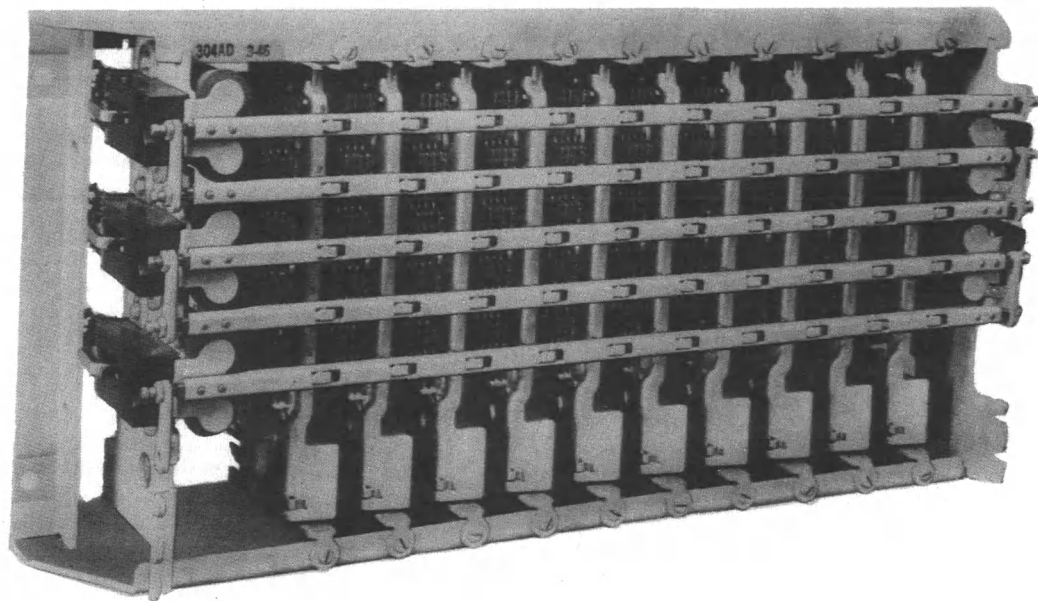
18.06 For lines having high-impedance ground (approximately 3640 ohms for a tip party station), relay 2P operates relays TPA and TPD. Relay TPD operates relay TPT. Relay TPA connects the tip and ring leads of the calling line to relay TP which operates if the line is grounded. However, relay TP is fast operating and may operate on line surges. To prevent false party identification, ground is removed from the TP armature pending the slow release of relay TPD, when relay F releases. If relay TP remains operated when TPD releases, relay TPI operates to indicate a tip party.

18.07 The release of relay TPD starts the timed release of relay TPT, which unlocks relay TPA. The release of relay TPA removes TP from the tip and ring leads and places relay L across the line. Dial tone is transmitted as described in 18.02.

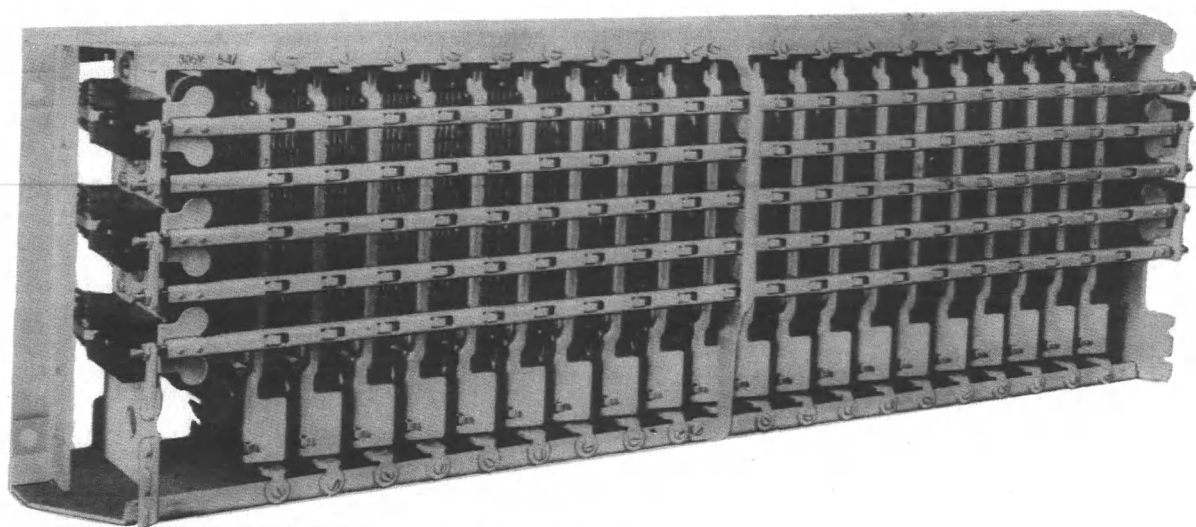
19. MARKER RELEASE (FS23-26)

19.01 The release of relay DCT operates the DIS1 and DIS2 (marker disconnect) relays. Relay DIS1 releases relays LLC1 and LLC2. Relays DIS1 and DIS2 operating cause the release of the marker check and control relays. They also release the MS- relay which controls the release of the marker connector. The marker is then available for a new seizure.





10—VERTICAL UNIT 100—POINT CROSSBAR SWITCH



20—VERTICAL UNIT 200—POINT CROSSBAR SWITCH

FIG. 1—TEN—VERTICLE UNIT 100—POINT CROSSBAR SWITCH AND A TWENTY—VERTICAL UNIT 200—POINT CROSSBAR SWITCH

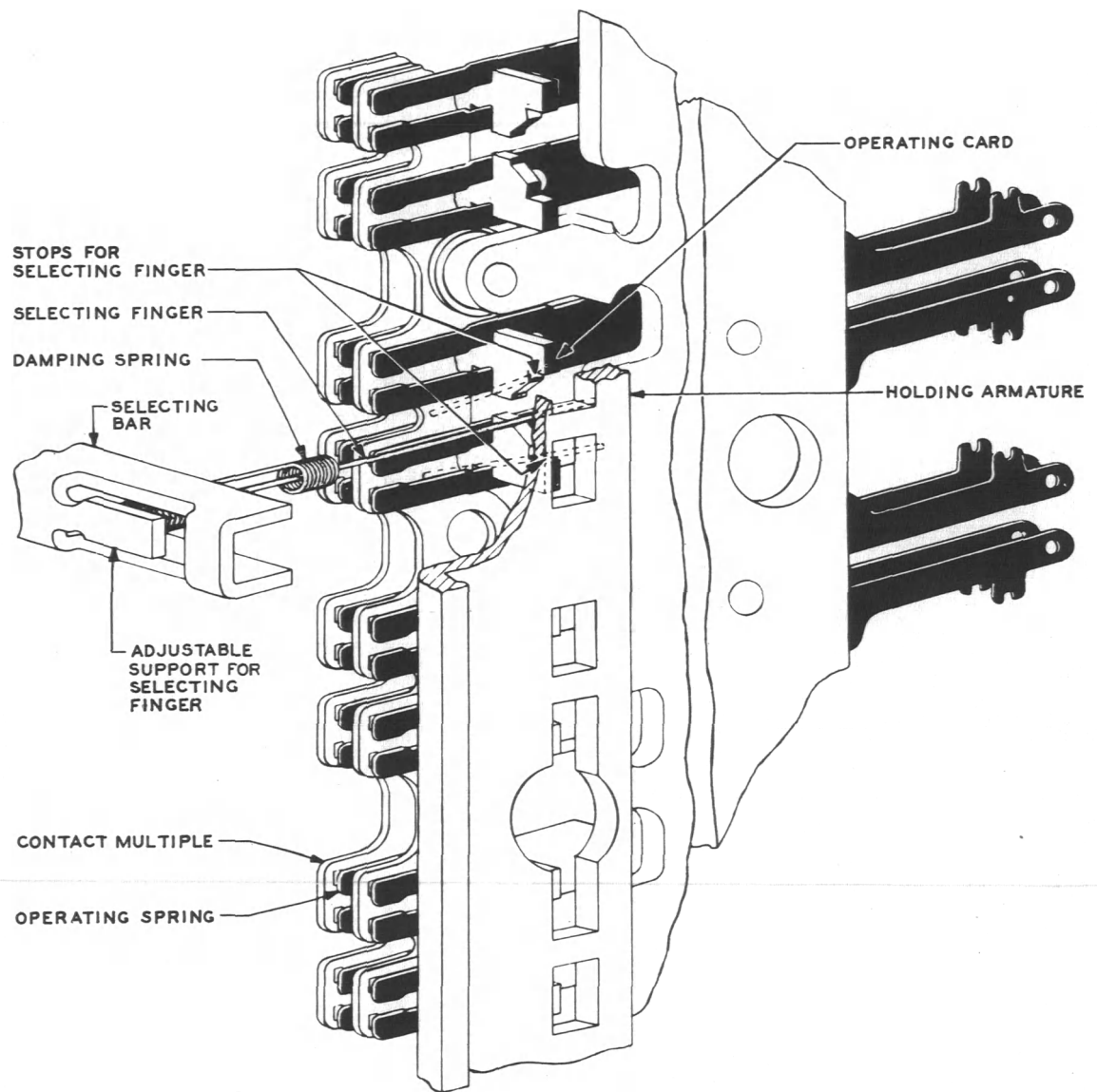
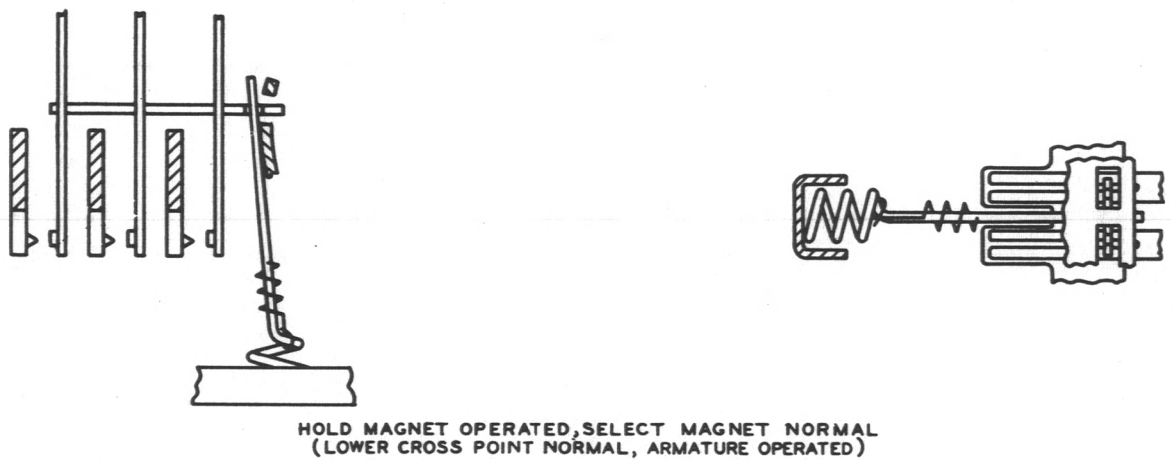
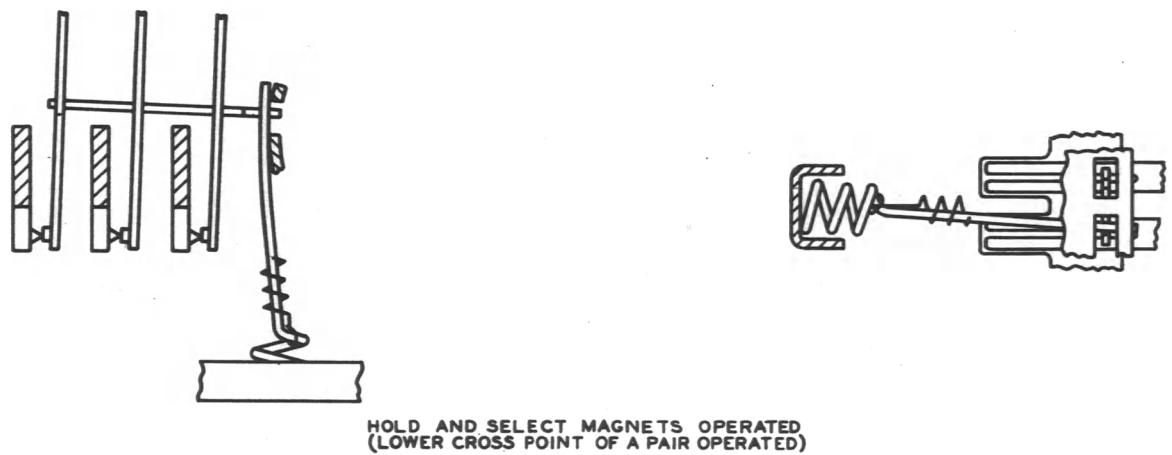
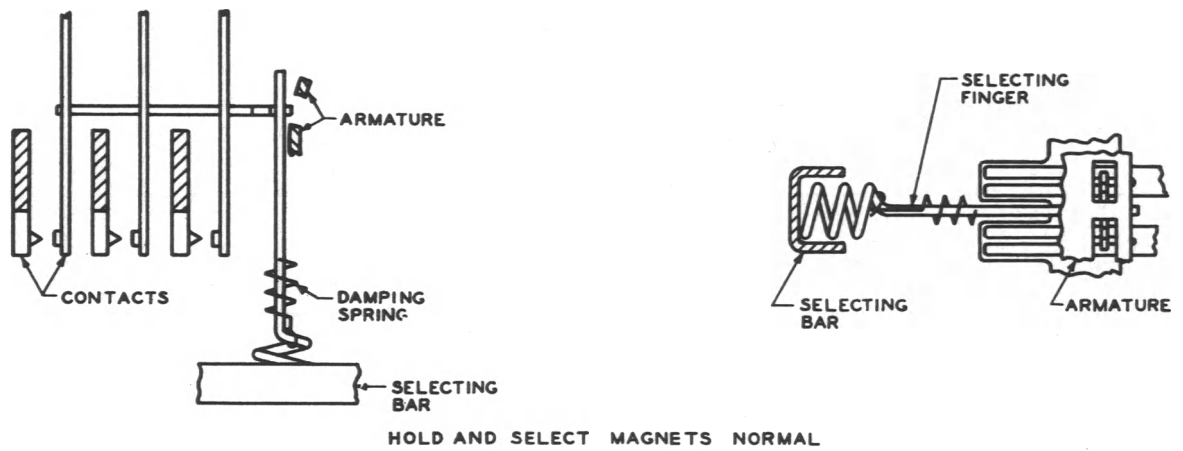


FIG. 2—PARTIAL PERSPECTIVE VIEW OF THE SELECTION ELEMENTS OF A CROSSBAR SWITCH



CROSSBAR SWITCH SELECTING MECHANISM

FIG. 3—CROSSBAR SWITCH SELECTING MECHANISM

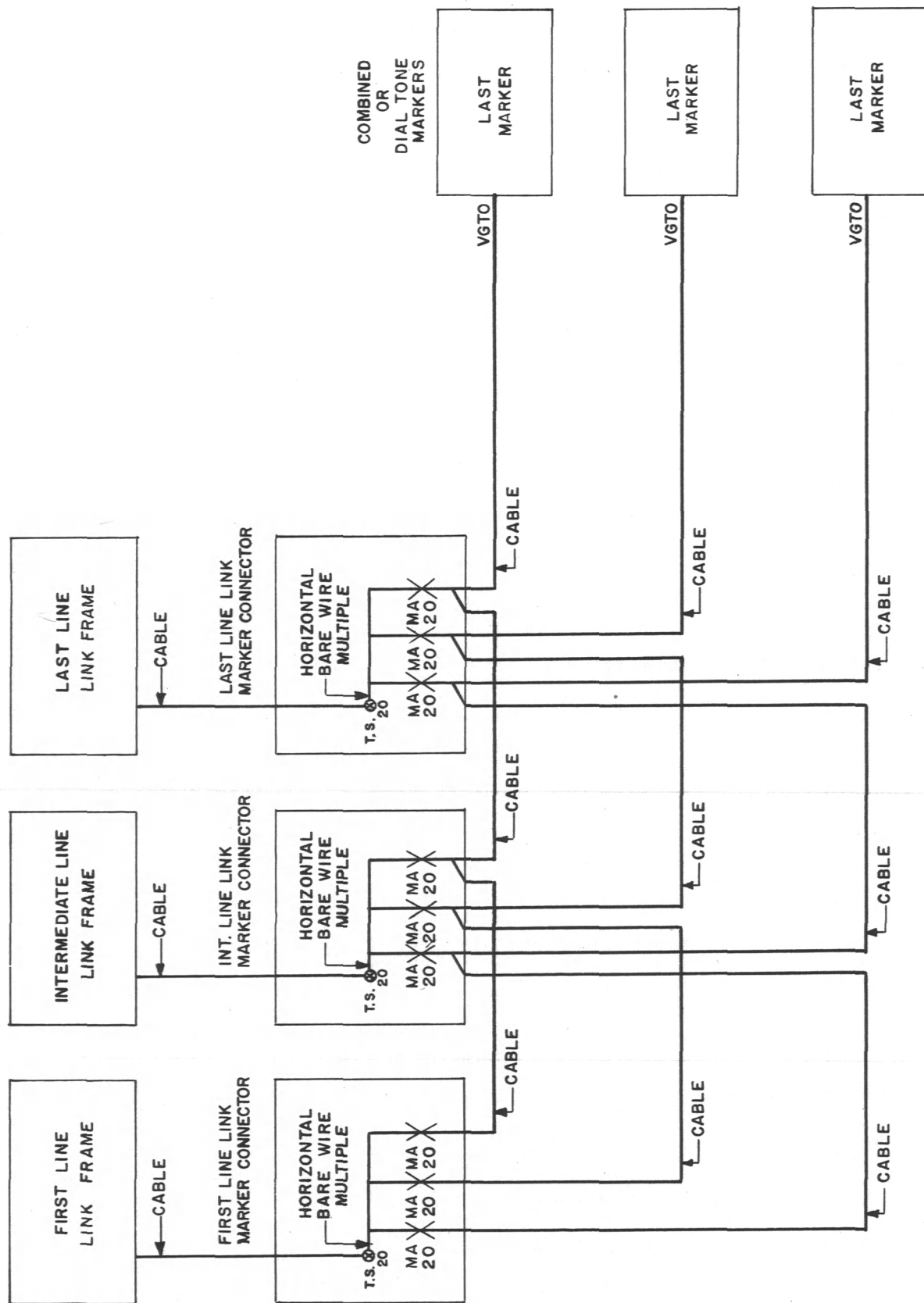


FIG. 4 — WIRING OF A TYPICAL LEAD (VGTO) THROUGH THE LINE LINK MARKER CONNECTORS

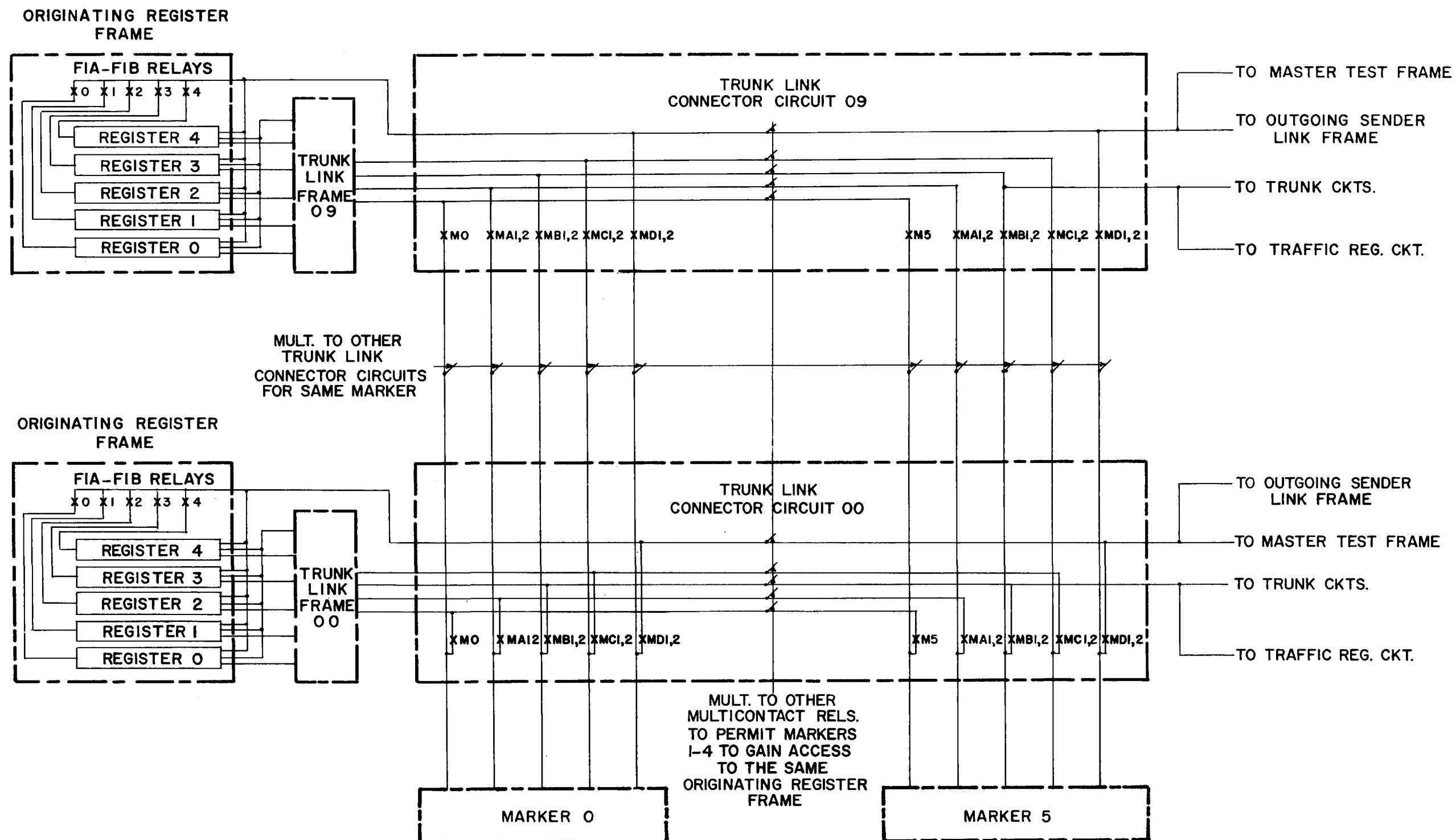


FIG.5—TYPICAL MULTIPLE ARRANGEMENT OF THE TRUNK LINE CONNECTOR CIRCUITS

TABLE A

ESTABLISHING THE DIALING CONNECTION - MAJOR FUNCTIONS

FUNCTION	KEY RELAYS		LOC.	OS	FS & SD	PUNCH INDICATION		TROUBLE RECORDER CARD COORD.	SC 701-1 LINE COORD.		REMARKS
	OPER.	REL.				PROG.	IDENT.		▼	▲	
Receiver Off Hook	L- VGS-		LL LL	701-1 701-1	FS1, 26030 FS2, 26030						
					FS25, 26001	HTR		S7 42	1A11	-	Hvy Traff
Marker Selection and Seizure	MS- MA- MB-		PCLLMC LLMC LLMC	701-1 701-1 701-1	FS2, 26029 FS26, 26001 FS28, 26001 FS1, 26022 FS1, 26022	TM	D	S7 1 S8 30	1N3 1B4	2H11 2N12	
Vert Grp Ident and Selection	VGT-	VGG-	M		FS6, 26001		VGT-	S3 30-41	1F5	2C12 1E9	Pref. Nonpref.
					FS26, 26001 FS11, 26001	DTK	TRK	S4 14 S8 55	1AG4 1U3	2K12	
Trunk Link Frame Selection	BC0 BC10 FS-	FB-	M M M	702-1 702-1	FS1, 26001 FS1, 26001 FS2, 26001 FS2-3, 26001	FCR	FS-	S8 39 S1 30-49	1L4 1L6	1K10 2X13	
Marker Route Selection				704-1	FS4, 26001 FS26, 26001		TBO TGO	S1 50-55 R8 30-49	- 1N3	- 2H11	
					FS23, 26001 FS27, 26001	CKG SNK		S8 31 S8 59	1J5 1N5	2P11 2AB11	
Test for Idle Orig Reg	FTC-		M	702-1	FS1, 2, 26001	FTCK		S8 40	1J5	2Y13	
Junctor Pattern Selection	PNR/PA P- JG-		M M M	706-1 706-1 706-1 706-1 704-1	FS16, 26001 FS18, 26001 FS14, 26001 FS16, 26001 FS5, 26001 FS13, 26001		SF/PR PNR/PA P- JG- TSE GTL	S1 56, 57 R6 46, 47 R6 50-59 R6 40-44 S8 45 S8 33	1Z5 1AD7 1AB10 1W8 1R6 1AA5	2X11 2AD12 2AU10 2AQ11 1T14 1K32	

TABLE A (Contd)

FUNCTION	KEY RELAYS		LOC.	OS	FS & SD	PUNCH INDICATION		TROUBLE RECORDER CARD COORD.	SC 701-1 LINE COORD.		REMARKS
	OPER.	REL.				PROG.	IDENT.		▼	▲	
Trunk Link Frame Seizure	MP- TFK1,2		PCTLG M	702-1	FS2-4,26039 FS3, 26001	CK		S8 41	1P8	2X12	
				710-1	FS16,26001 FS20,26001	TCHK LXPI		S8 48 S8 36	1AD9 2AA3 3Y8 3AA13	2AF12 2AS11 3X10 2AS11	Hvy Traff Lgt Traff Reoperates
				701-1 701-1	FS2, 26022-01 FS2, 26022-01		FR- CN-	S6 0-9 S6 10-13	1AJ4 1AJ4	2J12 2J12	
Line Link Frame Ident	FUT- FTB-		M M		FS10,26001 FS10,26001 FS10,26001 FS10,26001		FT- FU- FUT-	R1 0-3 R1 4-8 S4 34-43	1AA6 1AB6 1AB7	2M12 2M12 2AZ9	
				704-1 702-1	FS6, 26001 FS4, 26001 FS3, 26001	VTK1 TBK MAK1		S7 31 S8 44 S8 43	1E10 1Q10 1S10	2B13 2D11 2T12	
Junctor Cut-in	JG-		M	707-1-2	FS16,26001 FS17,26001		JC-	R6 30-39	1X9	2AN10	
Hor Grp Ident and Selection	HGT-	HGG	M		FS7, 26001		HGT-	S3 45-54	1D12	2E12 1E16	Pref. Nonpref.
Line Link Frame Seizure	MP- LFK		PCLLC M	703-1	FS2-4,26039 FS11,26001	LFK		S7 35	1G11	2AL13	
Orig. Reg Selection and Seizure	TS- F T-Sel	TSEL	M OR TL M	704-1	FS4,5,26001 FS11,26040 FS2, 26032 FS5, 26001		TS-	S0 30-39	1S12 1S16	2Z11 2AJ7	Even Odd
Recycle of Frame Memory	FM- (Present Usage)	FM- (Previous Usage) FMG	M M M	702-1	FS2, 26001 FS2, 26001 FS2, 26001	FML		S8 42	1M14	2W13	
				707-2 707-1-2 708-1	FS16,26001 FS17,26001 FS21,26001 FS7, 26001	EF/RF LK/RK JCK HTK1		S1 58,59 S8 49,50 S8 47 S7 32	1X9 1V11 1Y12 1C18	2AP12 2AZ11 2AR11 2E13	

TABLE A (Contd)

FUNCTION	KEY RELAYS		LOC.	OS	FS & SD	PUNCH INDICATION		TROUBLE RECORDER CARD COORD.	SC 701-1 LINE COORD.		REMARKS
	OPER.	REL.				PROG.	IDENT.		▼	▲	
Selection of Group of Trunk Links	LV- LC-	CHT-	TL TL M	710-1 710-1 710-1 710-1	FS1, 26032 FS1, 26032 FS19, 26001 FS22, 26001 FS19, 26001	LCK	LV- LC- FAK	R8 52-59 S0 50-59 R8 50 S8 46	1Q17 1T17 1Q18 1T18	2L8 2D8 2H8 2D9	
Selection of Group of Line Links	HG-	CHT-	LL M		FS2, 26030 FS7, 26001 FS19, 26001	HGK		S7 36	1D19	2AK12	
Marker Test Check	TK		M	708-1	FS21, 26001 FS11, 26001	TK DTK		S8 51 S8 55	1Z20 1Z21	2AE12 2AR7	
Vert File Ident and Selection	VGB- LG- VFT-	VFG	LL LL M M	705-1	FS2, 26030 FS2, 26030 FS8, 26001 FS8, 26001		VFT-	S3 55-59	1D21	2D12 1E24	Pref. Nonpref.
Channel Test and Selection	CHT- CH- CHA		M M M	708-1	FS19, 26001 FS21, 26001 FS21, 26001		CH-	R7 50-59	1Z22	2AG11	
					FS8, 26001	FTK1		S7 33	1D25	2D13	
Select Magnet Operation	J- L- LJ-		TL LL LL		FS2, 26032 FS1, 26030 FS1, 26030						
Class-of-Service Ident	CS-		M	705-1 705-1 705-1	FS12, 26001 FS12, 26001 FS12, 26001		CS- CT- CU-	S2 30-59 R1 25-27 R0 25-29	1E26 1E27 1H27	2AH11 2AL7 2U12	
Forwarding Calling Line Ident and Channel Number to Orig Reg	VG- HG- HG- VF		OR OR OR OR		FS9, 26001 FS14, 26040 FS9, 26001 FS14, 26040 FS9, 26001 FS14, 26040		VG'- HG'- VF'-	R0 9-14 R0 15-19 R0 15-19 R0 20-24	1V27 1S27 1Y27	2U12 2U12 2U12	

TABLE A (Contd)

FUNCTION	KEY RELAYS		LOC.	OS	FS & SD	PUNCH INDICATION		TROUBLE RECORDER CARD COORD.	SC 701-1 LINE COORD.		REMARKS
	OPER.	REL.				PROG.	IDENT.		▼	▲	
	MAN/2P CN LL- FT- FU-		OR OR OR OR OR		FS2-9,26040 FS12,26001 FS8, 26040 FS12,26001 FS14,26040 FS9, 26001 FS14,26040 FS10,26001 FS14,26040 FS10,26001 FS13,26001 FS13,26001 FS13,26001		MAN/2P CN LL- FT'- FU'-	S3 6,7 R4 31 S4 25-29 RO 0-3 RO 4-8 S8 56,57 S8 58	1B28 1B28 1P27 1X28 1AA28 1M31 1L31	2AG7 2AF7 2U12 2U12 2U12 2AL9 2RL1	
		GTL1,2,3	M			RK1,2 RK3					
Hold Magnet Operation	HMT HMS1 J-,L- J-,T-		M M LL TL	710-1 710-1 710-1 710-1 710-1	FS20,26001 FS20,26001 FS1, 26030 FS2, 26032 FS20,26001 FS20,26001 FS20,26001 FS20,26001	HMS1 GLH SL LTR CHE		S7 39 S7 43 S7 40 S7 40 S7 41 S8 35	2AFO 3AA4 3AA9 1AE7 2AN4 3AA8 2AF4 3Z8	2AE11 2AE11 2AC12 1AG25 2AU13 2AC11 2AT12 2AT12	Hvy Traff Lgt Traff Lgt Traff Hvy Traff (Reoperates) Lgt Traff (Reoperates) Hvy Traff Lgt Traff
Continuity Test	CON (tube) CON CON1 GT1		M M M M	 710-1	FS24,26001 FS24,26001 FS24,26001 FS20,26001	CON GT2		S7 44 S7 45	3W13 3W21 2AK4	3X17 3X24 2AN12	
Double Connection Test	DCT DCT1		M M		FS23,26001 FS20,26001 FS23,26001	DCT DCT1		S7 46 S7 47	2AD4 2AG5	2W8 2EL4	
Supervision Transferred to Orig Reg		DCT F	M OR		FS20,26001 FS11,26040						

TABLE A (Contd)

[illegible]

SECTION NO. 3

DIALING THE CALLED NUMBER



DIALING THE CALLED NUMBER

NO. 5 CROSSBAR OFFICES

CONTENTS	PAGE
A. GENERAL	2
B. DIAL PULSE COUNTING	3
1. General	3
2. Pulse Detecting Relay	4
3. Pulse Counting Relays	4
4. Digit Steering	4
C. DIGIT REGISTERS	5
1. General	5
2. Digit Registration	6
3. Preliminary Pulses	6
4. Prefix Counter	7
D. PRETRANSLATION	7
1. General	7
2. Extra Digit Timing	8
E. MARKER START	9
1. General	9
2. Example of Marker Start Operations	9

FIGURES

- 1 - Block Diagram of Originating Register Circuit
- 2 - Registration of Called Number 421

A. GENERAL

- 1.01 This section is one of a group which describes the detailed circuit operation of the various types of calls handled by the No. 5 Crossbar System with wire spring relays.
- 1.02 When the dial tone marker completes the dialing connection, it releases. The originating register is now ready for customer dialing. It sends dial tone to the customer as a "start dialing" signal, and then the customer dials the number he wants. This section of the text describes the operation of the dial pulse originating register as it receives and stores the digits of this number.
- 1.03 The originating register counts the dial pulses of each digit and translates the count into a two-out-of-five code. It stores this information until all the digits are dialed, then it calls in a completing marker and gives it the dialed number. Fig. 1 is a block diagram of the various parts of the originating register circuit.
- 1.04 In areas where a fixed number of digits is always dialed, the originating register summons a marker as soon as this number of digits is received. However, if the number of digits varies for different called offices, or varies because some lines have party letters, then the originating register must determine from the office code the number of digits to expect. This operation is called pretranslation. If the numbering arrangement of the dialing area is simple, and pretranslation of the A digit or the A and B digits can provide the required information, then the originating register may be arranged to perform these functions. In areas where the 2-5 numbering plan is in use, it is impracticable to have each originating register do its own pretranslation. When the pretranslation of these codes is involved, a separate circuit - the pretranslator - is used.
- 1.05 Where an originating register serves a 2-party customer, it has an additional task. It must find which of the two parties is dialing - the tip or ring party. The tip party is identified by a resistance ground on the tip side of the line in the telephone set. The ring party has none. So that the register doesn't make this test needlessly on every call, the dial tone marker gives it an indication when to make the test. The indication is the 2P (two party) relay in the originating register. The dial tone marker operates this relay in the originating register when it handles a 2-party line.
- 1.06 The originating register makes two party test before sending dial tone to a 2-party customer, and makes it again after the customer finishes dialing. There is a detailed description of the operation of the 2-party test circuit in the circuit description of the originating register - CD-26040.
- 1.07 When an originating register serves a call from a coin line, its action depends upon the options provided in the register circuit. The various conditions for coin line service are discussed in the originating register circuit description - CD-26040-01.
- 1.08 When dialing is over, the register puts out a demand for a completing marker. The marker answers the demand and completes the connection for the subscriber. The completing marker holds the originating register connection

to the subscriber until it is sure it can complete the call. If the completing marker has trouble finding an idle line link in the calling customers line link frame, it may have to use the one in the dial tone channel. By maintaining the dial tone connection throughout the completing job, it has this line link circuit available. Also, if for some reason, the call can not be completed, the marker then signals the originating register to send busy tone to the subscriber.

1.09 A timing circuit times the completion of the important originating register functions. If a function is not completed in the allotted time, time-out occurs and the register takes appropriate action. A detailed description of the timing circuit is in CD-26040 - Originating Register - Dial Pulsing.

B. DIAL PULSE COUNTING

1. General

1.01 Dial pulse counting consists of detecting and counting momentary opens (dial pulses). These pulses are generated by the subscriber's telephone dial as it returns to normal during the dialing process. One dial pulse is produced for the digit "one", two for the digit "two", and so on. Dialing a zero produces a train of ten dial pulses. Most telephone dials generate pulses at a rate of about ten per second. Certain PBX and switchboard dials produce pulses at a rate of twenty per second.

1.02 The number of pulses which make a digit is called a "train" of pulses. The pulses are equally spaced in time by the governor action of the dial as it returns to normal. The pulses of a dialed digit are separated from the pulses of another digit by a much longer period of time. This interval is called the interdigital period. This period of time between digits, depends on how long it takes the subscriber to spin the dial off normal after it has come to rest for the preceding digit. The period of time between any two pulses of a digit is less than one tenth of a second. The time between digits is much longer. The originating register recognizes this time difference as an indication of the end of a digit.

1.03 The L relay detects the dial pulses, the P1 to P5 relays count the dial pulses and the RA relay detects the end of a digit. Relay RA is a slow release relay. It is first operated by the release of the L relay during the first pulse of a digit. The relatively short closure periods of the L relay between pulses are not long enough for the RA relay to release. However, the much longer closure period between digits does allow the RA relay to release. In this way the originating register recognizes the last pulse of a digit by the long closure period which follows the last pulse. The SR relay supervises the connection for the originating register. It recognizes an abandoned call (subscriber disconnect) through its slow release time. The SR is operated through operated L relay contacts. Even though the L is released for each dial pulse, the release time is not long enough to release the SR relay. The SR relay is re-energized each time the L operates. However, if the subscriber hangs up before he finishes dialing, the L goes down and stays down. The slow release relay, SR, finally releases and disconnects the originating register.

1.04 The originating register receives a train of one to ten pulses for any dialed digit. The pulse detecting relay (L) responds to these dial pulses and the counting relays (P1 to P5) count the number of pulses in each digit. At the end of a digit the counted pulses are transferred to the proper digit register relays. The first digit is stored in the A register, the second in the B, and so on. This transfer happens during the interdigital period. When the digit number has been stored in the proper digit register, the operated counting relays (P1 to P5) are released. After this, the originating register is ready to receive the next digit.

2. Pulse Detecting Relay

2.01 Relay L is the dial pulse detecting relay. It is a magnetically biased, polarized, mercury contact relay. It has three windings. The primary, which is the line winding, is in series with the circuit to the subscriber. It operates when this circuit is closed through the subscriber's telephone switchhook contacts. The tertiary is a pulse aiding winding and is wired in the circuit to insure that the L relay remains operated for a short interval once it is operated, and also insures that it will remain released for a short interval once released. The purpose of this feature is to overcome bouncing of the L contacts. The secondary winding is poled opposite to the primary and acts as a biasing winding. When relay L is operated, the effect of the secondary makes it easier to release; once it is released, the secondary makes it easier to operate.

3. Pulse Counting Relays

3.01 Relays P1 to P5 and relay P2A are the pulse counting circuit relays. P1 relay operates on every other release of the L relay and P2 relay operates on every other operation of the L relay. In this manner, relays P1 and P2 follow the L at half the dial pulse rate and act as a pulse dividing circuit. For a digit six (six dial pulses) the L will release and operate six times. The P1 and P2 relays each will operate and release three times. The operation of the pulse counting relays is charted on SC 36 of SD-26040 - Originating Register Dial Pulsing.

4. Digit Steering

4.01 The digit steering relays (AS, BS...LS) connect the output of the operated pulse counting relays (P1 to P5) to the digit register relays (A0, 1, 2, 4, 7 - B0, 1, 2, 4, 7 ... L0, 1, 2, 4, 7). The steering relay circuit also tells the register when dialing is completed. The advance of the digit steers AS, BS, etc., is controlled by the RAL relay during the interdigital period.

4.02 We will follow the operation here of the steering relay advance on OS 711-1.

Relay AS (A digit steering relay) operates from operated ON relay when the originating register is set off normal by the dial tone marker. It locks through its own number eight contact and number six normal contacts of BS, CS ... LS relays to the ON ground. At the end of the first digit the L relay will remain operated long enough to allow RA to release. Released RA operates RAL. If two or more pulses were counted for the first digit, relay P2A is operated during the second pulse. Now there is an operating path for the BS relay. It is through its own normal number eight contact, operated number eleven contact of AS, operated number two contact of RAL, operated number four of P2A to ON

ground. Number six contact of the steering relays is a continuity transfer contact (early make-break). That is, the make part is closed before the break part opens. This allows the AS to hold up over a new locking path under control of the operated BS and RAL relays. The BS relay once operated, locks through its own operated number eight contact and through normal number six contacts of successive steering relays to ON ground.

4.03 When the first pulse of the next digit is received, the L releases, operating RA which in turn releases RAL. RAL opens the locking path of relay AS. With the AS relay released and the BS operated, the originating register is ready to store the second digit in the B digit register after it has been received and counted. The advance of the succeeding steering relays continues during the interdigital period of successive digits in the same way as described for AS and BS relays.

C. DIGIT REGISTERS

1. General

1.01 Originating registers are equipped for eight to eleven digits. The register is able to detect, count and store less than eight digits but the A to H register units are the minimum set supplied in an originating register. The additional relays required for extra digits are added as an option.

1.02 Each digit register is a unit consisting of five relay coils and associated contacts which are all enclosed in one cover. The coils are assigned the numbers 0, 1, 2, 4 and 7 so that the two-out-of-five numbering system can be used. We get a total of ten combinations using the two-out-of-five system. Now we can store any of the ten digits - zero through nine in a digit register. There is a digit register for each of the digits which the originating register is expected to store.

1.03 The units of the digit registers are called dry reed relays. The five coils of a digit register have one side of their windings connected to a common strap (OS 711-1). The end of this strap is brought out to a battery connection. The other side of each coil is connected to one of its own contacts. The mates of each of these sets of contacts are strapped together, brought out to a terminal, and connected to ON ground. This arrangement provides a locking path for each coil through its own make contacts. When the coil is energized. The other set of contacts also operate. They provide the information ground which is sent to the completing marker when dialing is finished. The two sets of make contacts for each unit of a digit register are mounted on metallic reeds and placed in separate glass tubes. The winding of each digit register coil is wound around the outside of the pair of glass tubes which make up the set. The winding of coil AO, for instance, is wound around the two sets of contacts (each set in a separate glass tube) which are associated with coil AO. When the relay coil is energized, the magnetic field of the coil bends the reeds so that they make two sets of operated contacts. These relays operate very fast - about 2-3 milliseconds. One set of contacts are a locking path, the other provides "information" ground to connecting circuits.

2. Digit Registration

2.01 Digit registration is the process taking place when an originating register after having counted the dialed pulses of a digit number, and after having recognized the last pulse as the completion of the digit, passes the counted number of pulses to the proper digit register for storing.

2.02 The L relay reoperates when the tip and ring are closed at the end of a dial pulse. Whenever the L relay operates, it opens the path of the slow release relay RA (OS 711-1). The RA relay will not release on operations of the L relay between pulses because the time the L is operated is not long enough to allow slow release RA to release. Each time the L relay releases during a pulse, it re-energizes the RA relay winding. After the last pulse of a digit however, the L will remain operated much longer - long enough for RA to release. The released RA relay closes ON ground through to the operated contacts of the pulsing relays (P1 to P5), through normal RAL contacts to the windings of the digit register relays. The released RA relay also operates the RAL relay, which opens the leads from the pulse counting relay contacts to the digit register. The digit register relays must operate and lock between the release of the RA and operation of RAL. Because they operate so fast, they can do it in this short period of time.

2.03 The operated RAL relay and released RA relay open the locking path for all operated counting relays during the interdigital period. After the counting relays have released and the digit register relays have operated and locked, the originating register is ready for the first pulse of the next digit. It does all this with time to spare during the interdigital period.

2.04 Fig. 2 shows the relay operations if the numbers 421 are dialed into an originating register. The periods of operation of the various relays are shown by horizontal lines. The left end of each line represents the point at which the relay is operated; the right end of the line represents the point where it is released.

3. Preliminary Pulses

3.01 If the subscriber accidentally jiggles the switchhook after receiving dial tone but before beginning to dial, it is quite possible that he will generate a false dial pulse. If the switchhook momentarily opens the line, the L relay will detect one pulse. This false pulse is not counted as a digit because if it were, it would cause a wrong number. The originating register is designed so that a digit of one pulse can't be stored in the A digit register.

3.02 If a pulse is accidentally sent by a jiggled switchhook, it is received in the originating register and detected by the L relay. When L releases it operates P1 and RA which in turn releases RAL. At the end of the false pulse, L will operate and remain operated since only one pulse is being sent. Operated L opens the path of RA, which being slow release, provides the time interval long enough so that the originating register can recognize the end of the digit. However, since only one pulse is counted, P2A relay hasn't operated. The paths for transmitting ground to the A0 and A1 register relays are open at the contacts of the P2A relay.

4. Prefix Counter

4.01 Certain codes use a "one" in the A and B digits - 11X service codes and 11 interarea directing codes for instance. Now we have a case where we must recognize and store a one in the first digit as well as the second. Yet we must guard against false preliminary pulses.

4.02 We use a 11 prefix counter to solve this problem. It is unlikely that two false ones will be generated by switchhook jiggling in such a way that they will be received as two distinct digits of one pulse each. Yet we must detect, count and store the 1-1 of 11X and 11 interarea codes.

4.03 The 11 prefix counter works like this. See SD-26040-01, FS 1, 2 and 4.

When the subscriber dials the first one, the L relay releases. Released L operates P1 and RA. RA releases RAL. At end of the pulse, which is also end of the digit, L reoperates operating P2. After L remains operated long enough, slow release RA relay recognizes this as end of the digit and releases which allows relay 11A to operate. Path of 11A is through six normal 11B, two normal P2A, two operated P1, two normal P5, two operated P2, seven normal RA, six normal MST1 to ON ground. Relay 11A locks to ON ground. Released RA also operates RAL which in turn releases P1 and P2. Release of P1 operates 11B through operated 11A, normal contacts of P1 to ON ground. Relay 11B locks to ON ground.

4.04 At start of the second one, L releases. P1 and RA operate through normal L contacts. RA releases RAL. At the end of the pulse, L reoperates. P2 relay operates through its own normal contacts, operated P1, normal RAL, normal MST1 through operated L relay contacts to ground. After L has remained operated long enough the originating register recognizes the end of the digit by the slow release time of RA relay. Released RA operates 11C relay. The path is through operated 11B, normal P2A, operated P1, normal P5, operated P2, normal RA, normal MST1 to ON ground. 11C locks to ON ground.

4.05 Now we have recognized a one in the A digit and a one in the B digit.

We have stored them in a separate digit register circuit, the 11 prefix counter. Subsequent digits will be stored in the A, B...L digit registers. The first of these subsequent digits will be a two or more. The register can't store a one in the A digit register even after receiving a 11 prefix. The path for operating the A0 and A1 digit register relays is through the operated P2A relay. This relay operates after the second pulse of a digit is detected. Once the P2A relay operates, it remains operated until the originating register releases. This makes it possible to store a one in any of the remaining digit registers.

D. PRETRANSLATION

1. General

1.01 If an originating register can know just how many digits a subscriber is going to dial, then it knows which is the last digit and therefore, when to summon a completing marker. Of course it is impossible to know how many digits a subscriber is going to dial before he starts dialing. However, if we examine the central office code, which is the first, first two or first

three digits after they are received and registered, we might be able to anticipate the number of digits which will follow. If we can do this, we can save originating register holding time simply because we won't have to wait after each digit and see if our customer is going to dial some more.

1.02 Pretranslation is a method which uses relays to examine the office code digits. The intent of this examination is to determine from the first (if only one such digit is dialed) the first and second (if two office code digits are dialed) or the first three digits in larger areas, how many digits in all may be dialed.

1.03 For simple numbering plan areas, one digit is sufficient for determining the central office desired. In this case we use an A digit translator circuit in the originating register. For larger areas two office code digits may be used. Here we use a 2-digit translator circuit (AB translator) in the originating register or a separate circuit called a pretranslator. For large dialing areas, the 2-5 numbering plan is in use. This method gives us a three digit central office code. Since the pretranslating circuit for three digit codes is complex, the function is taken out of the originating register. If we were to equip our originating registers with three digit pretranslating circuits, each one would be a complex and costly device. We use separate pretranslator circuits in three digit office code areas. Originating registers pass the three digits of the central office code to the pretranslator. The pretranslator examines the digits and informs the originating register how many in all to expect.

1.04 A detailed description of the operation of the A digit translator, and AB digit translator functions in the originating register, is in the circuit description - CD-26040 - of the originating register. The translation of three digit codes by the pretranslator circuit is discussed in Section 4 of this text under Pretranslation.

2. Extra Digit Timing

2.01 After the codes for certain offices are examined, either by the originating register circuit or by a separate pretranslator circuit, it may be determined that the subscriber is calling a manual office. We must realize that a large majority of the calls dialed into the originating register have the same number of digits. All the intraoffice calls and many outgoing calls have seven digits in areas using the 2-5 numbering plan. We will limit our discussion to this plan in the following examples. We arrange the originating register circuit so that it expects this number of digits on most calls, and waits for an additional digit on some others. Since a manual office has individual lines (4-digit numbers) and party lines (four digits and a letter) the originating register can't tell how many digits to expect - seven or eight.

2.02 We use an extra digit timer or stations delay circuit to solve this problem. After the three digits of the central office code are stored in the originating register, it sends these digits to the pretranslator. The pretranslator examines the code. If it finds it is for a manual central office, it will send back to the originating register a "stations letter signal." This signal tells the originating register to wait for a possible party letter after the seventh digit is stored. This signal will be returned

to the originating register before the subscriber has completed dialing the 0 digit. After receiving the G digit the register starts the extra digit timer. This timer allows the subscriber about 3.6 seconds to dial the party letter digit if he intends to do it. If the originating register does not receive the party letter digit, the timer will operate and cause the originating register to summon a completing marker. However, if the digit is dialed, the first pulse will release the L relay which will operate RA. RA will release RAL. Released RAL relay makes the marker start function of the extra digit timer ineffective. In this case, marker start occurs after the extra digit is received and stored in the originating register. A detailed description of the operation of the timer is covered in CD-26040.

E. MARKER START

1. General

1.01 The purpose of pretranslation is to tell the originating register how many digits to expect. The originating register can tell from the position of its steering relays when the last digit has been received on a seven digit call, and knows where to start the extra digit timer on a seven or eight digit call. After the first three digits were stored by the register, it summoned a pretranslator and passed these digits to it. The pretranslator examined the digits (office code) and told the register how many digits in all to expect. All this takes place very quickly. The register receives a signal from the pretranslator before the interdigital period between the third and fourth digits is completed. After the last digit is received, the originating register summons a completing marker and passes information to it. The marker completes the call or connection.

2. Example of Marker Start Operation

2.01 For instance, let us assume the subscriber is dialing a telephone number which is located in the same central office. In a 2-5 numbering plan area, the subscriber dials seven digits for this call. The first two digits are central office code letters, the third digit is the central office code number, and these are followed by four telephone number digits. Just as the C digit is stored, the DS steering relay operates. On OS 711-1 the DS operates the PST (pretranslator start). The pretranslator examines the A, B and C digits, finds they represent a seven digit call and informs the originating register to expect seven digits in all. The details of pretranslator seizure, operation and code translation are covered in another section of this text under the heading Pretranslation.

2.02 When the HS steering relay operates at the end of the G digit (last digit), ground is extended through its operated contacts (OS 713-2) through the G to CML cross-connection, normal CMB, CMC, CMB, CMA relay contacts, operated PST, normal DMS, normal SD, DMS to winding of MST (marker start) relay. Relay MST operates a register start relay RS - for this originating register in its marker connector.

2.03 OS 713-1 shows a path of the MST relay. Certain other options for coin service may be in series with this path. Their function is to have the register make coin tests, or return coins under certain conditions for coin

subscribers. The 2-party options makes the originating register do a 2-party test just before it operates the MST relay.

2.04 It is possible that a subscriber may dial a three digit code. Service codes such as 211, 411, etc. are in this class. The originating register sends the pretranslator the A, B and C digits as in the preceding call. However, the pretranslator recognizes that dialing is completed and then returns a signal to the originating register telling it to start for a marker right away - that is - after three digits. The path of the MST is through normal CR, 2P, SD, operated CM3, normal DMS, operated PST and RAL relays.

2.05 There is more to the details of marker start functions in the originating register. These details are discussed in the circuit description of the originating register - CD-26040.

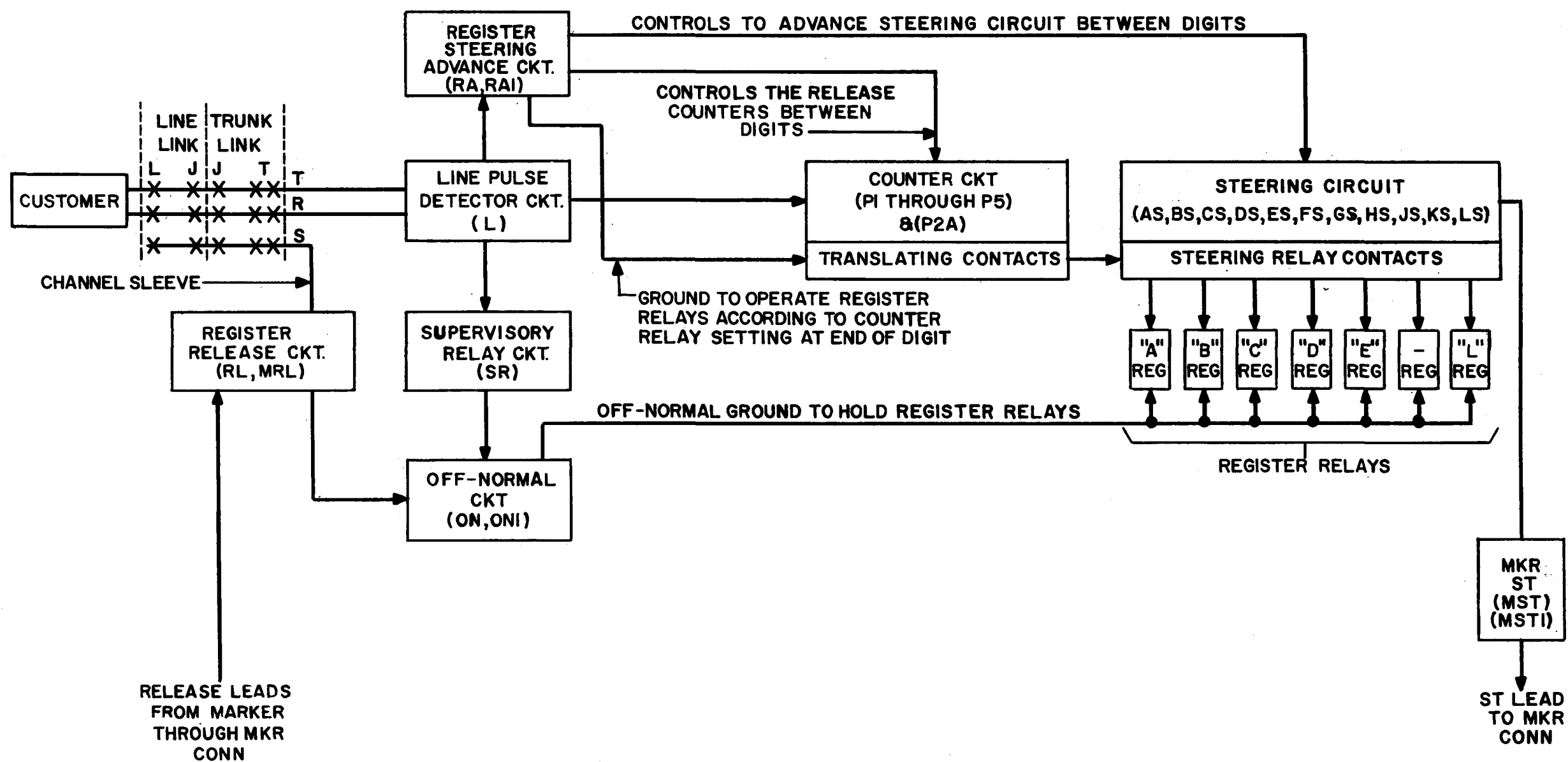


FIG.1 - DIAL PULSE COUNTING AND REGISTRATION

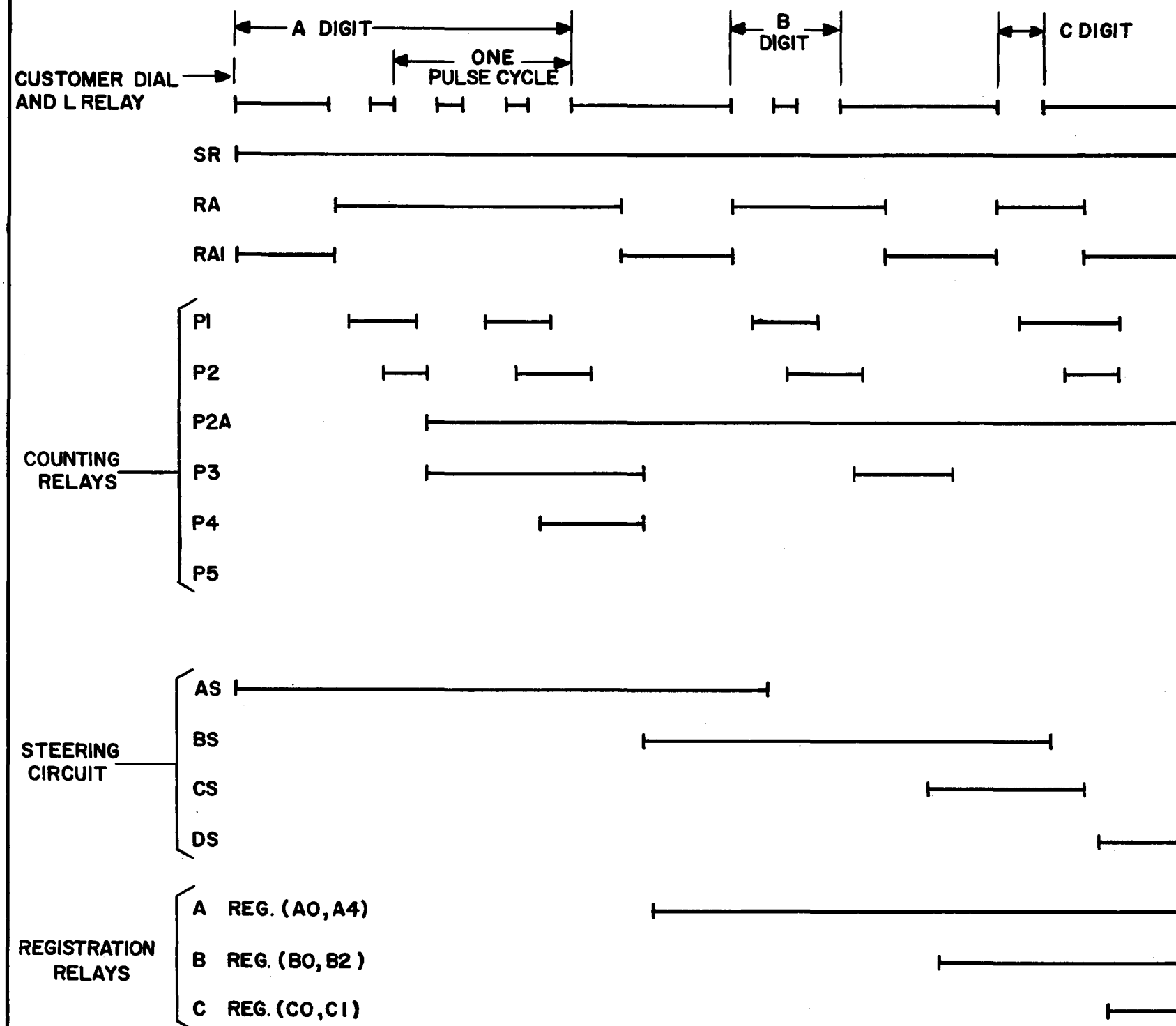


FIG.2- REGISTRATION OF CALLED NUMBER 421

SECTION 4

PRETRANSLATION



PRETRANSLATION

CONTENTS	PAGE
A. GENERAL	2
B. ESTABLISHING THE CONNECTION TO A PRETRANSLATOR	3
1. General	3
2. Pretranslator Start	4
3. Register and Subgroup Preference	4
4. Register and Subgroup Connector Relay Operation	5
5. Connection to the Pretranslator	6
C. PRETRANSLATOR OPERATION	8
1. General	8
2. Pretranslator Seizure	8
3. Receiving Leads	8
4. Indications to the Originating Register	9
5. Translation	10
6. Closure of the Transmitting Leads	14
7. Typical Example of Pretranslation	14
D. PRETRANSLATOR AND PRETRANSLATOR CONNECTOR RELEASE	17
1. General	17
2. Continuity Check of the Transmitting Leads	17
3. Control of the Pretranslator Connection	17
4. Operation of the Originating Register Circuit Release Relay	18
5. Lock Check	18
6. Pretranslator Connector Release	19
E. CONTROL FUNCTIONS	19
1. General	19

FIGURES

- 1 - Typical Cross Connections for a Three Digit Home Area
- 2 - Typical Cross Connections for a Three Digit Home Area where the Home Office is Arranged for XOX and XLX Codes

A. GENERAL

1.01 This section is one of a group which describes the detailed circuit operation of various types of calls handled by the No. 5 Crossbar System with wire spring relays.

1.02 This section describes the operation of the pretranslator circuit.

Pretranslation is a process of examining the dialed digits of a central office code with the intent to determine how many digits in all may be dialed. A telephone subscriber can dial different numbers of digits. For instance, if he dials a service code (211, 411, etc,) he dials three digits. If he dials the intraoffice code in a 2-5 numbering plan area, he dials seven digits. He may dial seven or eight digits for a manual office number. Individual lines have seven digits and party lines have eight digits. Customers who can dial toll calls directly, may dial ten or eleven digits. They dial ten digits for machine office telephones and manual office direct line (XOXABC1234). They dial eleven digits when calling party line phones in manual offices (XOXABC1234J).

1.03 If an originating register could know just how many digits a subscriber intended to dial, then it would know when the last digit was received. After this last digit was stored, the originating register could start for a completing marker. It wouldn't have to wait to see if the subscriber was going to dial more digits.

1.04 Of course, it isn't possible for the originating register to determine exactly how many digits the subscriber will dial every time. Yet there are certain categories that central office codes fall into which may help us solve the problem. If we can determine from certain central office codes just how many more digits to expect, we can save originating register holding time.

1.05 We can recognize certain codes such as 211, 411, 611, etc, as three-digit codes. If the originating register is told to summon a marker immediately after it receives one of these codes, we cut down on holding time. Cutting down on holding time is important because it helps to reduce the number of originating register circuits we need in our office.

1.06 If a subscriber dials the intraoffice code in a 2-5 numbering plan area, then we can have the pretranslator circuit tell the originating register that the seventh digit is the last digit. The register can start for a completing marker as soon as this G digit is stored. We can treat calls for dial central offices like this. Codes for manual offices present a different situation. The originating register can't know if the subscriber is going to dial a number for an individual or party line. So, the register must wait for the extra digit (party letter). For manual office codes, the pretranslator tells the register to start an extra digit timer at the end of the G or seventh digit. This gives the subscriber enough time to dial a party letter digit.

1.07 Where the numbering arrangement of the local area is not complex, the originating register does the pretranslating functions. The process of pretranslating codes in the originating register is discussed in CD-26040. Where it is complex, it is more economical to concentrate these functions in common pretranslator circuits. Pretranslators are also required for foreign area customer dialing (FACD) to distinguish between local or home area calls and foreign area calls. Pretranslators are reached by the originating registers through pretranslator connectors.

1.08 One pretranslator is able to handle the traffic in most offices; however, an additional pretranslator is always provided for maintenance purposes. Two pretranslators may serve two marker groups when office codes receive the same translation in both groups. The holding time of pretranslators is short - about 160 milliseconds.

1.09 The originating register summons a pretranslator after either the second digit (2-4 numbering plan) or the third digit (2-5 numbering plan) is received. It seizes the pretranslator connector and then the connector seizes an idle pretranslator. The connector closes two groups of leads from the originating register to the pretranslator. The first group of leads transmits the digits representing the central office code from the registration relays in the originating register to the code register relays of the pretranslator. These are the receiving leads, because it is through them that the pretranslator receives the code which it is to translate. The pretranslator then translates the code into one of several possible indications. The second set of leads, called the transmitting leads, is used to return this indication or "start index" to the originating register. For any particular code, the pretranslator sends one indication.

1.10 This section describes the operation of both the pretranslator and pretranslator connector circuits as they perform these functions. It describes the arrangement of the pretranslators in numbering areas using three-digit office codes and foreign area directing codes.

B. ESTABLISHING THE CONNECTION TO A PRETRANSLATOR

1. General

1.01 An originating register has access to either pretranslator through the pretranslator connector circuit. One pretranslator connector is provided for each pretranslator. Each pretranslator connector has access to both pretranslators. The arrangement of pretranslators, connectors, and originating registers is shown on the block diagram of OS 713-1, Sheet 1.

1.02 Each connector can serve a maximum of 60 originating registers which are divided into three subgroups with a maximum of 20 registers per subgroup. This arrangement reduces the number connected to a common multiple and reduces the service hazard which may be caused by an open or cross in this multiple. An originating register connects to the subgroup multiple through its associated PRA- relay. A subgroup connects to the common connector through the GA- and GB- relays. The connector circuit has access to the pretranslator through the PA- and PB- relays. All registers on the same register frame are assigned to the same connector subgroup to simplify the

wiring of the PRS- (register preference) and PRA- (register connector) relays. These relays are located on the same register frames as their originating registers. All other connector circuit equipment is located on the pretranslator frame.

2. Pretranslator Start

2.01 The originating register can start for the pretranslator after the second or third digit (OS 711-1). It depends upon the office code and whether straightforward call completion is involved. In two-digit office code areas also having two-digit straightforward codes, the pretranslation is started after the second digit. In all other cases, pretranslation is made after the third digit. The 11 prefix is not included in the digit count because it is not included in the registration but is counted on a separate prefix counter.

2.02 In a three-digit (2-5 numbering plan) central office area, the originating register starts for the pretranslator after the third digit is stored. After the C digit is registered, relay DS- (D digit steering) operates. Relay DS- operates relay PST- (pretranslator start) which locks and starts selection of a pretranslator by seizing the connector. This is done by connecting the battery to a start lead. This battery operates the associated PRS-relay (OS 712-1) through the register preference chain.

3. Register and Subgroup Preference

3.01 Two relay chain circuits are provided in each connector to evenly distribute pretranslator service to all registers which request it. These are the register preference chains and the subgroup preference chain (OS 712-1). Each register preference chain consists of all the PRS- relays for the registers in a subgroup (maximum of twenty PRS- relays). This chain determines the preference when two registers in the same subgroup want a pretranslator. Three of these chains are provided per connector - one for each subgroup. The subgroup preference chain is three GS- (group selection) relays, one for each register subgroup. This chain determines the preference when two originating registers in two subgroups of a connector want pretranslator service at the same time. Each of these chains is described in the following paragraphs.

3.02 The operating ground for the PRS- relays is closed through a chain of normal contacts of these relays. It starts at the last register. The chain uses parallel contacts of the PRS- relays and bridged leads to prevent a single open lead or contact from denying some registers access to the connector.

3.03 When an originating register connects battery to its ST- lead it operates its associated PRS- relay through normal contacts of all succeeding (higher numbered) PRS- relays. Once operated, the PRS- locks through its own contacts to ground. If no other PRS- relays are operated at the time, the operated PRS- relay closes two parallel paths (with bridged leads) to operate its PRA- relay in series with the GS- relay in the subgroup. These leads are carried through a normal contact chain of all preceding PRS- relays in the subgroup. The PRS- contacts of the first register are closest to the functional ground. This ground is supplied through the normals of the BR- and GR- relays in the connector. This gives the lowest numbered originating

register preference for operating its associated PRA- relay if two or more registers operate their PST- relays. Other calls are served in turn when ground is made available to them by the release of the preceding PRS- relays.

3.04 There are two chain grounds at work in this PRS- relay circuit. The first one is the operating ground for the PRS- relays. In this circuit the higher numbered PRS- is preferred. In fact, even after a certain PRS- relay is operated, a higher numbered PRS- can operate to this ground. However, once operated and locked, the lower numbered PRS- relay has preference for operating its associated PRA- relay. This is so because it is nearer to the functional ground - a chain circuit which runs opposite to the operating ground. A PRS- relay can operate over a path through its own normal contacts to the locking ground of a lower numbered PRS- relay which is operated even though a higher numbered PRS- relay is operated and waiting. For instance, if PRS0 is operated and being served by the connector, a demand from the register two can operate PRS2 - If in the meantime register one demands pretranslator service, it can operate its PRS1 through its own normals and operated contacts of PRS0. The number twelve contacts of the PRS- relays, those in the operating chain, are continuity transfer contacts (make before break). The higher numbered PRS- relay waits its turn for the functional ground. When the last operated PRS- relay releases, ground is restored to the lead through which the PRS- relays operate. The relays for preceding registers which have waiting calls operate. The preference chain again determines the order in which they are served.

3.05 The GS- relays are arranged in a chain circuit so that only one demand from a subgroup can be served when other subgroups in the connector are waiting for service. Relay GSO may be operated independently of both the GSl and the GS2 relays. Relay GSl, however, can operate only when GSO is normal. When operated, it locks, so that subsequent operation of GSO will not release it. Similarly, relay GS2 can operate only when GSO and GSl are normal, and once operated, it locks independently of these relays.

3.06 Contacts of the GS- (group start) relays are wired in a chain circuit. The ground originates at normals of the GK- relay contacts (OS 712-1, Sheet 2 upper left hand corner) and is connected to the contacts of GS2 first, GSl, and then GSO relays. This is the functional ground circuit for the subgroups. This arrangement gives preference to the higher numbered subgroup GS- relay which is operated.

4. Register and Subgroup Connector Relay Operation

4.01 The PRA-relay closes the receiving and transmitting leads from the register to the associated subgroup connector relays. On OS 712-1, Sheet 1, it also extends start battery through resistors STA and STB over leads STA and STB to the pretranslator connector. Start leads A and B are used alternately for selecting a pretranslator. Resistors STA and STB protect the register battery supply and prevent a trouble ground on one start lead from affecting the other.

4.02 Relay GC- operates its GA- and GB- (subgroup connector) relays. GA- and GB- relays close the receiving and transmitting leads through to the pretranslator connector relays and operate the GCA- relay for the subgroup. Relay GCA- operates the GK and GK1 (subgroup check) relays that are common to the three subgroups in the connector. These relays remove ground from the operating circuit of the GC- relays so that no other subgroup can operate its GC- relays.

4.03 Here we have another example of a double chain circuit. For the operating ground, relay GS0 is preferred, GS1 next preferred and GS2 is last. In the functional ground circuit, relay GC2 is closest to the ground through the GK and GK1 relays. GC1 is next and GC0 is last in the chain.

5. Connection to the Pretranslator

5.01 Two relay chain circuits are used in the pretranslator connector to select the preferred pretranslator. These are the CB- (connector busy) relay chain and the PS- (pretranslator start) relay chain. Each of these chains consists of one CB- and PS- relay for each pretranslator in the group. The following paragraphs describe these chains.

5.02 When a pretranslator is busy on a call, it operates its CB- relay in the connector not being served. For example, on OS 712-1 when pretranslator zero is busy serving pretranslator connector zero, it operates the CBO relay in connector one. The operation of any GC- relay in connector one locks the CBO relay operated. This prevents a call from reverting to a more preferred pretranslator if one should become idle. The circuit is arranged so that one CB- relay must be normal to complete the path for locking the other if it is operated. This prevents a request for a pretranslator from blocking itself if both pretranslators are momentarily busy.

5.03 The operation of relay GC- (subgroup connector) extends the start battery from the originating register on leads STA and STB through the W and Z relay combination and normal contacts of relay TRS- to either the STA or STB punching. Relay Z is released for one call and operated for the next. It alternately closes leads STA and STB on successive calls. This permits each connector to alternate its pretranslator preference, which distributes the usage evenly. There is a detailed description of the W and Z walking circuit operation in the section of the text - Dial Tone Call.

5.04 In connector zero on OS 712-1, Sheet 2, STA is cross connected to PS0 and STB to PS1. This arrangement makes pretranslator zero the first choice pretranslator for start lead A and makes pretranslator one first choice for start lead B.

5.05 When battery is closed through one of the start leads, it operates relay PS-, which corresponds to the preferred pretranslator available, through normal contacts of its associated CB- relay in the connector. The operating ground for relay PS- is furnished either directly from pretranslator punching PSG or through contacts of the PS- relay chain circuit. If both pretranslators are busy, the call is delayed momentarily until one becomes idle.

5.06 The PS- relays for the same pretranslator are wired in a chain through the connectors. If two connectors call for the same pretranslator at about the same time, both of the PS- relays may operate and lock. The one nearer the PSG ground has the preference and can seize the pretranslator. On OS 712-1, Sheet 2, PS0 (pretranslator start relay -0) in connector one is closest to the operating ground. For pretranslator number one, the operating ground is nearer to PS1 in connector zero.

5.07 Let's assume that the first originating register in connector zero, subgroup zero (extreme left of Sheet 1, OS 712-1) is demanding service. Let's assume also that the Z relay in pretranslator connector zero is operated. This opens start lead A and closes start lead B. Now we can trace a path for operating a pretranslator start (PS-) relay in the pretranslator connector zero.

5.08 The path is from battery in the originating register through operated PST (pretranslator start) and normal PRL (pretranslator release) relays in the originating register to the start leads in the subgroup connector. We continue through the STB resistor, operated PRA, operated GCO over lead four to Sheet 2. On Sheet 2 we continue through operated Z contacts, normal TRS to the STB-PS1 cross connection, through normal CBI, the winding of PS1 and down the sheet to the PSK1 to PSG cross connection and ground in pretranslator one. This operates the PS1 relay for pretranslator number one in connector number zero. PS1 releases the normally operated PC- and PS- relays in the pretranslator. These relays guard chain circuits through the connectors. They start the pretranslator timer when they release.

5.09 Relay PS1 operates PC1 through normal contacts of the PS1 relay in connector one to ground in the pretranslator. While PS1 relay in connector zero was closer to the operating ground, it is less preferred for the functional ground which operates the PC1 relay in connector zero. PC1 operates PA1, PB1, and PK in the connector. The PA1 and PB1 relays close leads from the connector to the pretranslator. Now we have a complete circuit for the transmitting and receiving leads from the originating register to the pretranslator. PA1 and PB1 operate PCAL. Relay PCAL operates the MB relay in the pretranslator which in turn operates the CBI relay in connector number one. Ground through operated MB in the pretranslator over CB2 lead to the primary winding of CBI relay in connector one to battery through the resistor. The MB relay also extends ground over the CBI lead to the winding of CBI relay in connector zero. However, the other side of the primary winding of this relay is also grounded through operated contacts of PC1 relay and this prevents CBI from operating. The secondary winding is open at its own contacts and the primary winding is short-circuited by the grounds connected on each side. The circuit is designed this way so that CBI relay in connector zero can't operate; if it were allowed to operate it would open the operating path of PS1 relay and we would knock our own demand out of the connector. The CBI relay in connector one is operated so that a subsequent demand for pretranslator one coming in from connector number one can't override our own demand.

5.10 There is a feature built into the pretranslator connector which prevents a demand, which has been shifted to the lesser preferred PS- relay, from reverting to the higher preferred PS- once the demand is in the connector. Assume on this call we have a demand coming over start lead A in connector zero and that pretranslator zero is busy with a demand in connector one. We would find CBO relay in connector zero operated by the battery

on its primary winding to the ground on operated MB relay in pretranslator zero. This would shift our start lead battery away from PSO, through operated contacts of CBO relay to the winding of PSI relay. Pretranslator one would be seized. However, suppose that pretranslator zero finishes with its demand while our register is engaged with pretranslator number one. If we don't keep CBO relay operated, our demand will revert to pretranslator zero during our call. This would mean releasing pretranslator one and seizing pretranslator zero. This is not desirable.

5.11 To prevent this, CBO is held up. There is a path from battery at the secondary winding of CBO, through its own operated contacts, over to the normals of CBI and back on the LCB lead to the operated GC- relay on Sheet 2 (lead 15) to ground. This holds up CBO relay in connector zero while our demand is being served. To lock up, a CB- relay must go through normals of another CB- relay. This feature prevents both CB- relays from becoming locked operated. At the end of this call, the GC- relay releases and in turn releases the CBO relay. Now the connector is restored to normal.

C. PRETRANSLATOR OPERATION

1. General

1.01 The connector has completed its job of selecting a pretranslator and establishing the connection between it and the originating register which is requesting pretranslation. The pretranslator assumes control of the connector. The central office code digits are now sent to the pretranslator. Grounds from contacts of the A, B, and C digit register relays are extended through the operated PRA-relay for the originating register, through the operated GA- and GB- relays of the subgroup and through the PA- and PB- relays of the connector. The translation index - 11 or LT - also passes through to the pretranslator. On OS 713-1, Sheet 1, we can see how these grounds operate storage relays in the pretranslator. The pretranslator examines the digits of the office code, translates them into a marker start indication, and sends this signal back to the originating register. The pretranslator checks the transmitting leads for continuity from the pretranslator through the connector to the originating register.

2. Pretranslator Seizure

2.01 When PC- and PS- relays in the pretranslator released, they started the pretranslator circuit functions. The connector relays PRA, GA-, GB-, PA-, and PB- have connected many leads from our register to the pretranslator.

3. Receiving Leads

3.01 As the subscriber dialed the A, B, and C digits of the central office code, they were stored in the originating register on digit register relays. Now we have paths from the grounds on the contacts of these register relays through the connector relays to the AC-, BC-, and CC-relays in the pretranslator. Two out of five AC-, BC-, and CC-relays are operated and they correspond to the digits in the originating register. If a trouble record were taken, the punches would have the same designation as the operated originating register relays.

3.02 Foreign Area Directing Code Calls: If calls using 11 directing codes require a different number of digits than the local area office codes, we use the LT- relay (local translator) and 11X relay (11 translator). When a subscriber dials an 11 prefix code, the 11C relay in the originating register is operated. This is described in Section three of this text - Dialing the Called Number. The operated 11C relay in the originating register transfers ground from the LT to the 11 lead. This is shown on OS 713-1, Sheet 1. The ground on the 11 lead operates 11X relay in the pretranslator. If the subscriber doesn't dial an 11 prefix before dialing the ABC digits of the central office code, then the LT lead is grounded. This ground operates LT- relay in the pretranslator. The 11X relay in the pretranslator sets up the pretranslation of 11 foreign area codes. When pretranslation of 11 codes is not required, relays LT- and 11X are omitted because all calls receive local translation. The pretranslator is used with 11-prefix call only in offices where 11 is used as a foreign area directing code.

4. Indications to the Originating Register

4.01 Pretranslation is the conversion of an input code to an output code.

The input code is a two-out-of-five code representing the central office code dialed. The output code is one of the indications which is returned to the originating register. The input is applied by passing the office code on a two-out-of-five basis from the register to the pretranslator. Before describing the pretranslation, we will look at the output signals.

4.02 Eight signals to the register can be used for assigned central office codes. Two other signals can be used where the register calls a marker after it receives two or three digits. Indications are given to the register when ground is connected to transmitting punchings BS or CM- as follows:

(a) Punching BSS represents the basic setting. BSS is used for the number of digits which originating registers receive on most calls. Usually the number of digits received on intraoffice calls is associated with the basic setting (BSS punching). For instance, in a central office area where we have a 2-5 numbering system, the register gets seven digits on intraoffice calls. We would probably assign the BSS punching to these codes and to other connecting offices which have the same number structure. This punching is also used for foreign area codes which require the same total number of digits (not counting the 11 prefix as digits).

(b) Punching BSP is used for central office codes which have the same number of digits as the basic setting, but require stations delay because of party letters or numbers over 9999.

(c) Punchings CMSA, CMSB, and CMSC are used for additional settings when the office code digits plus telephone numerals add up to a different number from the digits of the basic setting. They may represent any number of digits without stations delay.

(d) Punchings CMPA, CMPB, and CMPC represent the same number of digits as the corresponding CMS- punchings, but signal the register for stations delay.

(e) Punching CMS3 is used to signal the register to call a marker, without returning coin, after two digits are dialed in two-digit offices having AB straightforward codes, or after three digits are dialed in all other offices.

(f) Punching CMP3 is also used to signal the register to call a marker after two or three digits, except that the register is instructed to return the coin on coin lines before doing so.

5. Translation

General

5.01 The following paragraphs describe the arrangement and operation of the translator relays and the cross connections which make them effective. Before we do this we should consider the number of central office codes which must be translated. First we shall exclude those ABC codes which are not used for central office codes. The originating register will go for a completing marker if the first digit is zero. The register won't accept a one in the A digit. It does recognize two ones (11) as a prefix to the A digit. The B digits zero and one are reserved for use with foreign area customer dialing (FACD) area directing codes. The C digit zero is not usually used for office codes, but when it is, it is more economical to provide a supplementary group of relays (C zero translator relays) to translate it.

5.02 From this analyzation we can see that the digits we must consider are:

A digits 2 to 9 = 8 digits
B digits 2 to 9 = 8 digits
C digits 1 to 9 = 9 digits

This permits a maximum of 64 combinations of A and B digits (8 x 8) and 576 combinations of A, B, and C digits (8 x 8 x 9).

Translation of Three-Digit Office Codes

5.03 The 576 codes which must be pretranslated are divided into 192 groups of three consecutive codes each. This arrangement permits the three consecutive codes to be translated as a group through a single cross connection. However, we can still change the translation of one code of a group without changing the other two codes of the same group. Each of the 192 groups is associated with three punchings similarly numbered but designated R, S, and T. The numerical prefix of each punching designation corresponds to the A and B digits of the office code: --R punchings represent codes with C digits 1, 2, and 3; --S punchings represent codes with C digits 4, 5, and 6; and --T punchings represent codes with C digits 7, 8, and 9. For example, punching 22R represents codes 221, 222, and 223; 59S represents codes 594, 595, and 596; while 99T represents codes 997, 998, 999.

5.04 In a seven-digit area without foreign area directing codes, the home area office codes require only three signals to the register. The signals are:

- (a) Office codes of three digits followed by four numerical digits - Pretranslator signals register to call marker after seven digits.
- (b) Office codes of three digits followed by either five numerical digits or four numerical digits and possibly a party letter - Pretranslator signals register to provide stations delay after seven digits.
- (c) Vacant codes - Pretranslator signals register to call marker after three digits.

5.05 The three indications (a), (b), and (c) above are designated W1, W2, and W3 respectively. If we take any three consecutive central office codes, we can see that each of these can receive one of the three treatments W1, W2, or W3. If we start setting down on paper the various permutations of this arrangement as has been done in Table A, we see that there are twenty-seven different arrangements. These twenty-seven different arrangements are represented by punchings P0 to P26.

TABLE A

P	U	V	W	P	U	V	W	P	U	V	W
0	W1	W1	W1	9	W2	W1	W1	18	W3	W1	W1
1	W1	W1	W2	10	W2	W1	W2	19	W3	W1	W2
2	W1	W1	W3	11	W2	W1	W3	20	W3	W1	W3
3	W1	W2	W1	12	W2	W2	W1	21	W3	W2	W1
4	W1	W2	W2	13	W2	W2	W2	22	W3	W2	W2
5	W1	W2	W3	14	W2	W2	W3	23	W3	W2	W3
6	W1	W3	W1	15	W2	W3	W1	24	W3	W3	W1
7	W1	W3	W2	16	W2	W3	W2	25	W3	W3	W2
8	W1	W3	W3	17	W2	W3	W3	26	W3	W3	W3

5.06 The three consecutive codes in any one group are represented by U, V, and W where U represents the lowest-numbered code of the group and W the highest. Thus U represents the C digits 1, 4, or 7, V the C digits 2, 5, or 8, and W the C digits 3, 6, or 9. The pattern numbers in the table correspond to the P- punchings. For instance, if punching 22R is cross connected to P0, codes 221, 222, and 223 all receive the W1 treatment. If punching 595 is cross connected to punching P5, codes 594, 595, and 596 receive the W1, W2, and W3 treatments, respectively. Since punchings W1, W2, and W3 are permanently cross-connected in these offices to BSS, BSP, and CMS3 or CMP3, respectively, the cross connections between punchings P- and punchings --R, --S, and --T are the only variables in the pretranslator.

5.07 An additional group of eight relays (BA2 through BA9) is provided to help translate digits A and B of the code. Each of these relays is wired in series with its corresponding B- relay. Thus both relays B- and BA- are operated in series when the corresponding B digit is registered.

5.08 Two groups of relays are provided to translate the C digit. The first group, relays CR, CS, and CT (C digit primary translator relays), completes the conversion of the code received into a ground on an --R, --S, or --T subgroup punching. The second group, relays CU, CV, and CW and their auxiliaries CUA, CVA, and CWA, make up the C digit secondary translator. These relays convert ground on a P- punching to a particular start indication W1, W2, or W3 for each code. The only exceptions to this are punchings P0, P13, and P26. It is not necessary to translate the C digit when these patterns are used because they provide the same treatment for the three codes of each group.

5.09 The operation of one or more of relays BC2, BC4, BC7, CC2, CC4, and CC7 operates relay CR, CS, or CT through contacts of the operated CC- relays and windings of CU and CUA; CV and CVA, or CW and CWA to 62-ohm resistance battery.

5.10 So far in this discussion we have assumed that all codes with a zero in the C digit are vacant. When this is true, a zero in the C digit doesn't operate any of the C digit translator relays. Instead, it grounds either punching VCR or lead CMS3.

5.11 C Zero Codes Assigned for Use: If any codes with zero in the C position are assigned, relays CZ2 through CZ9 (C zero translator) and CZC (C zero connector) are provided. One of relays CZ2 through CZ9 is operated in series with the corresponding B- and BA- relays after the B digit is registered. Registration of a zero C digit operates relay CZC, which closes ground from two operated AC- relays through the operated CZ- relay to a single code punching of the 220 through 990 group. Each of these punchings is an individual code point for the code it represents and is cross-connected to punchings BS and CM- as required. Fig. 1 shows typical cross connections for a three-digit home area.

X11 Code Translation

5.12 X11 codes may be used as service codes or as manual straightforward codes. Registration of a one in the B digit grounds code point X1. A one in the C digit grounds punching X11 in offices which translate three-digit office codes. The A digit is not translated in either case, because it does not change the indication given for this type of code. The appropriate X1 or X11 punching is cross-connected to punching CMP3 or CMS3 as required, see Figs 1 and 2.

11 Foreign Area Directing Code Translation

5.13 The operation of relay 11X indicates on 11-prefix call. Translation of this call is provided only when the foreign area office code represents a different number of digits than the home area office code. However, only the A digit of the 11 call is translated. Operation of the A-digit register relays closes ground through contacts of the 11X relay to the 11X2 to 11X9 punchings. Each of these punchings which is used is cross-connected to punching BS- or CM- as required. Punching 11X0 is treated as a vacant code punching.

XOX and XLX Code Translation

5.14 The foreign area customer dialing (FACD) program involves direct customer dialing on a nationwide basis and uses XOX and XLX codes as national area codes. The XOX and XLX codes are used only in areas where the home office codes consist of three digits. The pretranslator can distinguish XOX and XLX foreign area codes from local area codes. The C-zero translator relays are provided to do this. On OS 713, Sheet 2 we see that the CZ0 to CZ9 relays are in series with the B-digit translator relays. They are in fact auxiliaries to B-digit translator relays. If the pretranslator receives an XOX or XLX code, either CZ0 or CZ1 relay will operate. For local area codes (which never have a zero or one in the B digit) one of the relays CZ2 to CZ9 is operated. These relays are used to separate toll directing codes from local central office codes. Punchings W1 and W2 are cross-connected to punchings WA and WB, respectively. This provides two paths for local codes and two paths for foreign area directing codes. Punching W3 is cross-connected directly to CMP3 or CMS3 for three-digit code indication. For home area office codes, punchings WA and WB are connected by the operation of relays CZ2 through CZ9 to punchings W4 and W6, which are cross-connected to punchings BSS and BSP for a seven- and eight-digit indication, respectively. For XOX and XLX codes, punchings WA and WB are connected by the operation of relay CZ0 or CZ1 to punchings W5 and W7, which are cross-connected to either punching CMSA or CMPA for ten- or eleven-digit indication, respectively. Punchings CMSB and CMPB, or CMSC and CMPC may also be used for other indications if they are needed.

5.15 Each --H, --S, --T punching represents three XOX or XLX codes having A digits 2 through 9, B digits 0 or 1, and C digits 1 through 9 (X11 codes being excluded). These punchings are cross-connected to punchings P0 through P26 in a manner similar to three-digit home area office codes. On calls involving X11 codes, ground is connected to punching X11 and is not connected to the corresponding punchings X1R. When the pretranslator receives an X11 code (211, 411, etc.) it connects ground to the X11 punching. Ground is not present on the corresponding --H punching because the CR-relay is not operated. For example, suppose a subscriber dials 211, the AC 0 and 2, BC 0 and 1, and CC 0 and 1 relays are operated; the CR-relay is not operated and so the 21R punching is not grounded. The 21R punching represents codes 211, 212, and 213. Therefore, these punchings may be cross-connected to any R-punching that satisfies the conditions required for the second and third codes of the group without regard to the first (X11) code. For example, if code 212 requires 10 digits and code 213 requires 11 digits, punching 21R may be cross-connected to any one of punchings P1, P10, or P19. The X11 punching is grounded through the CCO and 1, BCO and 1, and LF-relay contacts. The X11 punching is cross-connected to either CMS3 or CMP 3 punchings. This will signal the originating register to call the marker after three digits.

5.16 Punchings 200, 300, etc., and 210, 310, etc., are individual code points for the corresponding XOX and XLX codes. They are cross-connected directly to punchings CM--.

5.17 Punchings which represent vacant codes are cross-connected to CMS3 or CMP3. CMS3 signals the register to call a marker after three digits. CMP3 signals the register to return a coin and then call the marker after three digits.

6. Closure of the Transmitting Leads

6.01 When one of the punchings on Sheet 3 of OS 713-1 is grounded through a cross-connection, one of the five transmitting relays CMA, B, C, 3, or BS is operated. Whichever one operates depends on the cross connection. It will operate in series with either the PW (primary winding) or SW (secondary winding) relay. This arrangement uses seven relays for ten indications. The XR-relay provides a cross detection circuit. It will operate if two or more of the ten punchings are grounded. The resistance of one path doesn't allow enough current to flow to operate it. If it does operate, it opens its own biasing circuit which insures that it will stay up if the trouble should disappear.

6.02 Here is a table which shows how grounds on the ten transmitting punchings on the left side of OS 713-1, Sheet 3, cause pretranslator relays to operate and leads from the pretranslator to the originating register to be closed:

<u>Punching</u> <u>Grounded</u>	<u>Relays</u> <u>Operated</u>	<u>Leads</u> <u>Closed</u>
BSS	BS, SW, SW1	NONE
BSP	BS, PW, PW1	SD
CMS3	CM3, SW, SW1	CM3
CMP3	CM3, PW, PW1	CM3, SD
CMSA	CMA, SW, SW1	CMA
CMPA	CMA, PW, PW1	CMA, SD
CMSB	CMB, SW, SW1	CMB
CMPB	CMB, PW, PW1	CMB, SD
CMSC	CMC, SW, SW1	CMC
CMPC	CMC, PW, PW1	CMC, SD

The operation of one of the CM- relays closes ground to the similarly designated lead through the pretranslator connector circuit to operate the corresponding CM- relay in the originating register. The operation of relay PW1 grounds lead SD through the connector to operate register relay SD-(stations delay).

7. Typical Example of Pretranslation

7.01 Let's suppose a subscriber is dialing a telephone which is in his own office. This is an intraoffice call. In a 2-5 numbering plan area, he dials seven digits. Our originating register would have option C on OS 711-1, Sheet 2. This option lets the register start for the pretranslator at the end of the third digit. This digit is the end of the central office code. For instance if the central office code is 595, the originating register has received and stored digits 595 on the A, B, and C digit registers. Now the register operates its PST relay and we place our demand in the pretranslator connector. This demand is answered just as we discussed in Part B of this section.

7.02 When the originating register is connected to the pretranslator, the A, B, and C digits, 595, are sent to the AC1 and AC4, BC2 and BC7, CC1 and CC4 relays on OS 713-1, Sheet 1. The LT- (local translation) relay in the pretranslator would be operated from ground in the originating register.

7.03 On OS 713-1, Sheet 2 we can see contacts of the BC2, 4, and 7, and CC2, 4, and 7 relays in the upper left-hand corner. BC2, BC7, and CC4 relays would be operated on this call. Now we have a path from ground through operated contacts of these relays and LT- contacts to operated BC2 and BC7 relay contacts through windings of B9, BA9, and CZ9 in series. The BC2 and BC7 are operated from the nine in 595 code.

7.04 In lower left-hand corner we have contacts of BC-, CC-, and LT- relays which supply ground to winding of CR-, CS-, and CT- relays. These C digit auxiliary relays split the C digit into three groups. CR represents C digits one, two, and three. CS represents C digits four, five, and six. CT represents C digits seven, eight, and nine. Because our C digit (595 code) is a five, we should find a path through winding of the CS- to contacts of CC1 and CC4 relays. We notice that this path is in series with two relays CVA and CV. All three relays CV, CVA, and CS- operate.

7.05 The CR-, CS-, and CT- relays split the C digits one to nine into three groups. The CU and CUA, CV and CVA, CW and CWA relays also split the C digits one to nine into three groups, but in a different way. We can set up a little table which shows how these relays act as coordinates for pinpointing the C digit.

TABLE B

	<u>CU</u> <u>CUA</u>	<u>CV</u> <u>CVA</u>	<u>CW</u> <u>CWA</u>
CR	1	2	3
CS	4	5	6
CT	7	8	9

We can see that any combination of one relay of CR-, CS-, and CT- combined with one of the pairs of CU(A), CV(A), CW(A) gives us an exact definition of the C digit.

7.06 This arrangement is used to simplify pretranslator cross connections.

If we represented all the codes which could be dialed on individual punchings, we would have a large cross-connection field. In the pretranslator, this C digit translation arrangement cuts the cross-connection field by a third.

7.07 To continue with our call, in the middle of Sheet 2, OS 713-1 we have contacts of AC1 and AC4 relays which are operated because our A digit is five. We have a circuit from the ground through AC- relay contacts, option C, operated CS- and operated B9 relay to the 59S punching. This punching stands for the central office codes 594, 595, and 596. Punching 59S is cross-connected to one of the PO-P26 punchings which give the correct indications for the three codes.

7.08 We have already said that our code - 595 - is a seven-digit code. If we know what the two associated codes, 594 and 596, require we can pick the proper P- punching for our cross connection. Lets assume that code 594 is vacant and code 596 is a manual central office. Now we know that the P- punching we choose must indicate a three-digit marker start for the first code, seven-digit start for the second, and stations delay (seven or eight-digit) for the third.

7.09 Table A on Page 11 shows the various marker start signals which the PO to P26 punchings represent. The symbols W1, W2, and W3 stand for seven digits, eight digits and three digits in that order. What we want is three digits (W3) for 594, seven digits (W1) for 595, and eight digits (W2) for 596 in that order. There is one punching which gives us this indication - P19. So we cross-connect 59S to P19.

7.10 Following through our circuit path, the grounded is now present on the P19 punching. We can continue through operated CVA contacts to the W1 punching.

7.11 In central offices without foreign area customer dialing, W1 punching is cross-connected to BSS on Sheet 3. In offices with this service, W1 is cross-connected to WA punching on Sheet 2. The C2-9 relays are provided when XOX and XLX toll codes are translated. If we had this feature, the C25 relay would be operated for our call, moving the ground to the W4 punching. This is cross-connected to the BSS punching on Sheet 3. In either case, the BS and SW relays are operated. This is called the basic setting of the pretranslator operation. When the pretranslator has its BSS punching grounded, it doesn't send a marker start signal to the originating register. It just sends a pretranslator release (PRL relay) signal which the originating register recognizes as a seven-digit marker start indication. For all other marker start indications, the pretranslator sends the originating register a signal by operating one of the CMA, B, C, 3, or SD-relays in the originating register. On our call, only the PRL operates. It releases DMS (delay marker start). The DMS relay is in the circuit so that the originating register will wait for the signal from the pretranslator. On most calls the signal is received soon enough so that the originating register doesn't have to wait for it after the customer finishes dialing. On our call for instance, the originating register would have the marker start signal before the subscriber finishes dialing the D digit.

7.12 The subscriber now dials the four digits of the telephone number. When the seventh digit is received and stored, we have digits in the A to G digit register relays. At the end of the last pulse of the G digit, the L operates and remains operated. The slow release RA- relay releases operating RAL and the G two-out-of-five register relays. RAL operates the HS steering relay. Now we have a path from the MST relay winding on OS 713-1, Sheet 3 through normals of CR, 2P (the dialing subscriber does not have two-party class of service) through normals of DMS, SD, DMS, operated PST, normal CMA, CMB, CMC, CM3 to the CML punching. This punching is cross-connected to the G punching which is grounded by operated HS. This operates the MST relay.

D. PRETRANSLATOR AND PRETRANSLATOR CONNECTOR RELEASE

1. General

1.01 After passing its translation to the originating register, the pretranslator checks the continuity of the transmitting leads used on the call. It does this before it releases. It also supplies holding grounds and a holding battery to the connector to maintain the connection to the originating register, and checks the hold circuit. It then operates the PRL-(register release) relay (OS 713-1).

1.02 Relay PRL-locks any of the originating register translation relays that are operated over transmitting leads (OS 713-1). This makes sure the start index is not removed before it can be used by the originating register. The pretranslator checks that the required transfer relays are locked. If they are, or if none of the transfer relays are required (basic setting indication), the pretranslator removes the connector holding circuits, which release the connector. Release of the connector relays releases the operated pretranslator relays.

2. Continuity Check of the Transmitting Leads

2.01 The CCM-(continuity CM) and CSD-(continuity SD) relays (OS 713-1) are provided to check the continuity of leads CM- and SD- if either or both leads are used to transmit the start index to the register. These relays operate in series with the operated translation relays in the originating register. The operation of each of these relays indicates a continuous operating circuit on the transmitting lead used.

3. Control of the Pretranslator Connection

3.01 The operation of relay PW1 or SW1 operates and locks the HD (hold) relay (OS 713-1). Relay HD closes battery through lamp HD and the winding of relay HDK (hold check) to lead HD to the connector (OS 712-1). This supplies a holding battery for the operates PS- and PRS-relays. It also prevents the release of PS- and PRS-when originating register relay PRL-is operated, and permits the pretranslator to check the locking of the required register transfer relays.

3.02 The operation of relay HD also grounds leads G1 and G2, which hold pretranslator connector relays PRA-, PRE-, and GS-. This also denies the use of these leads to any originating register requesting a pretranslator connector. The arrangement allows the pretranslator to hold the connection until its functions are completed.

3.03 Relay HD also grounds lead GR, operating the connector GR- (ground removal) relay (OS 713-1) which is associated with the pretranslator in use. Relay GR- removes the operating ground from relays PRA-, PRE-, and GS- (OS 712-1). When the connection is released later in the call, the release of relay GR- delays the reclosure of these grounds which prevents overlap between successive calls.

3.04 The operation of relay GR- also grounds lead PCK (OS 713-1) to the pretranslator, operating relay PCK (pretranslator control check). This indicates that all of the control relays in the connector are operated.

4. Operation of the Originating Register Circuit Release Relay

4.01 The operation of relay HDK grounds lead PRL to the connector when the continuity check of the transmitting leads is satisfactory (CCM and CSD operated). This operates register relay PRL. Lead PRL is wired through parallel contacts of relays CCM and BS and then through parallel contacts of CSD and SWL. This is done because relay BS is always operated if none of the CM- leads are used and because relay SWL is operated if lead SD is not used.

4.02 The operation of register relay PRL opens the pretranslator connector start lead (OS 712-1) and provides a locking ground for register relays CM- and SD- (OS 713-1). The opening of the start lead has no effect because relays PRS and PS- are held by battery supplied over lead HD.

4.03 Relay PRL is double-wound (OS 713-1): lead PRL connecting to the primary winding, and lead RLK to the secondary. When operated, it locks through both windings and returns ground to the pretranslator on both leads. The RLK ground operates pretranslator relay RLK (release check). Relay RLK locks to ground through both the PRL and RLK leads from the connector.

5. Lock Check

5.01 Two check circuits are provided to check the application of the locking ground to either relay CM- or SD-, or both. Each of these check circuits has two operating methods, depending on the start indication provided.

5.02 The operation of relay LCM (lock CM-) indicates that either the operated CM- register relay is locked or that the operation of a CM- relay is not required (OS 713-1). Similarly, the operation of relay LSD (lock SD-) indicates that either the operated SD- register relay is locked or that its operation is not required by the start indication of the call.

5.03 For any translation, either relay BS or CM- and the SWL or the SD relay operate. If the BS or SWL relays operate, the CM- or SD- lock tests are not required. The operation of relay RLK then directly operates relays LCM or LSD.

5.04 However, if neither BS nor SWL operate, the operation of RLK operates relay KTR (check transfer). This transfers the pretranslator end of leads CM- and SD from relays CCM and CSD, used in the continuity check, to relays LCM and LSD for the lock check. This releases CCM and CSD. If the locking ground is present on either or both of these leads, relays LCM and/or LSD operate.

5.05 When operated, both LCM and LSD lock to ground through relay RLK. An additional locking ground is supplied for relay LCM through the operated PWL or SWL relay to prevent false momentary operation of relay HD during release.

6. Pretranslator Connector Release

6.01 Pretranslator relay HD holds relays PRA-, PRB-, and GS- by ground on leads G1 and G2 and relays PRS- and PS- by battery on lead HD. The operation of relays LCM and LSD opens the operating and holding circuit of HD (OS 713-1). This releases HDK (OS 712-1) in the pretranslator and removes battery from lead HD, thereby releasing PRS- and PS-. Relay HD also removes ground from leads G1, G2, and GR, releasing relays PRA-, PRB-, GS-, and GR-. These leads are opened simultaneously to prevent false start which might otherwise occur if lead HD were opened first.

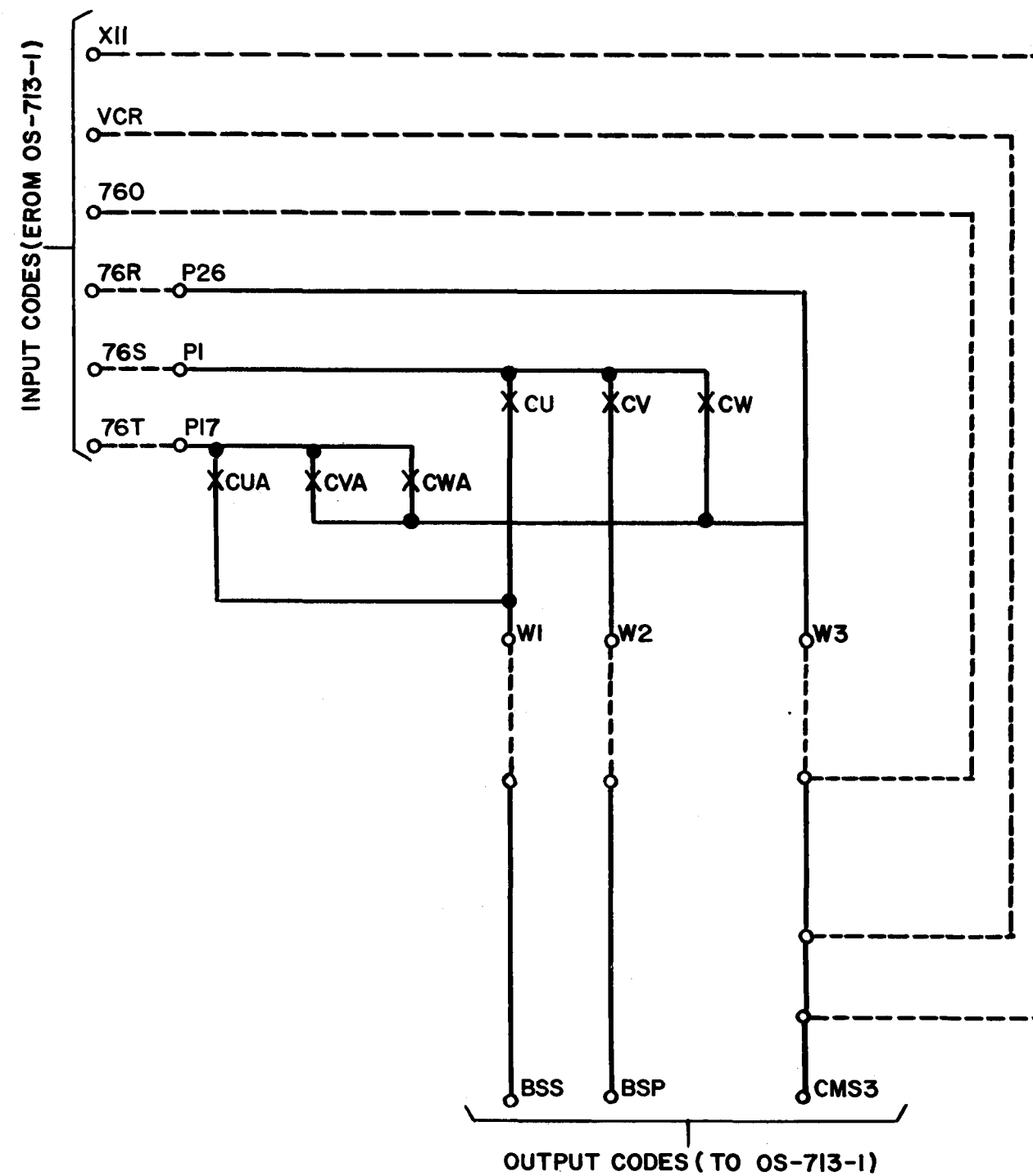
6.02 The release of PRA- and PRB- opens the receiving leads, which releases any of the relays AC-, BC-, CC-, LT-, and 11X that are operated (OS 713-1). This releases operated translator relays. The release of relays AC- causes the release of BS or CM-, PW or SW, and PW1 or SW1 relays (OS 713-1). The release of PW1 or SW1 releases LCM.

6.03 The release of relay PS- closes chain circuits PSK and PCK to reoperate pretranslator relays PS- and PC-. It also releases connector relay PC- which allows relay CB- in the connector being served to operate, and releases connector relays PA- and PB-. Relay PC- releasing, causes relay Z to either operate or release, depending upon its condition (OS 712-1). The release of relays PA- and PB- releases PCA-, thereby releasing relays PK, PCK, and MB. The release of MB releases all CB- relays. Release of relay GS- causes relays GC-, GA-, GB-, GCA, GK, GK1, and GR- to release.

E. CONTROL FUNCTIONS

1. General

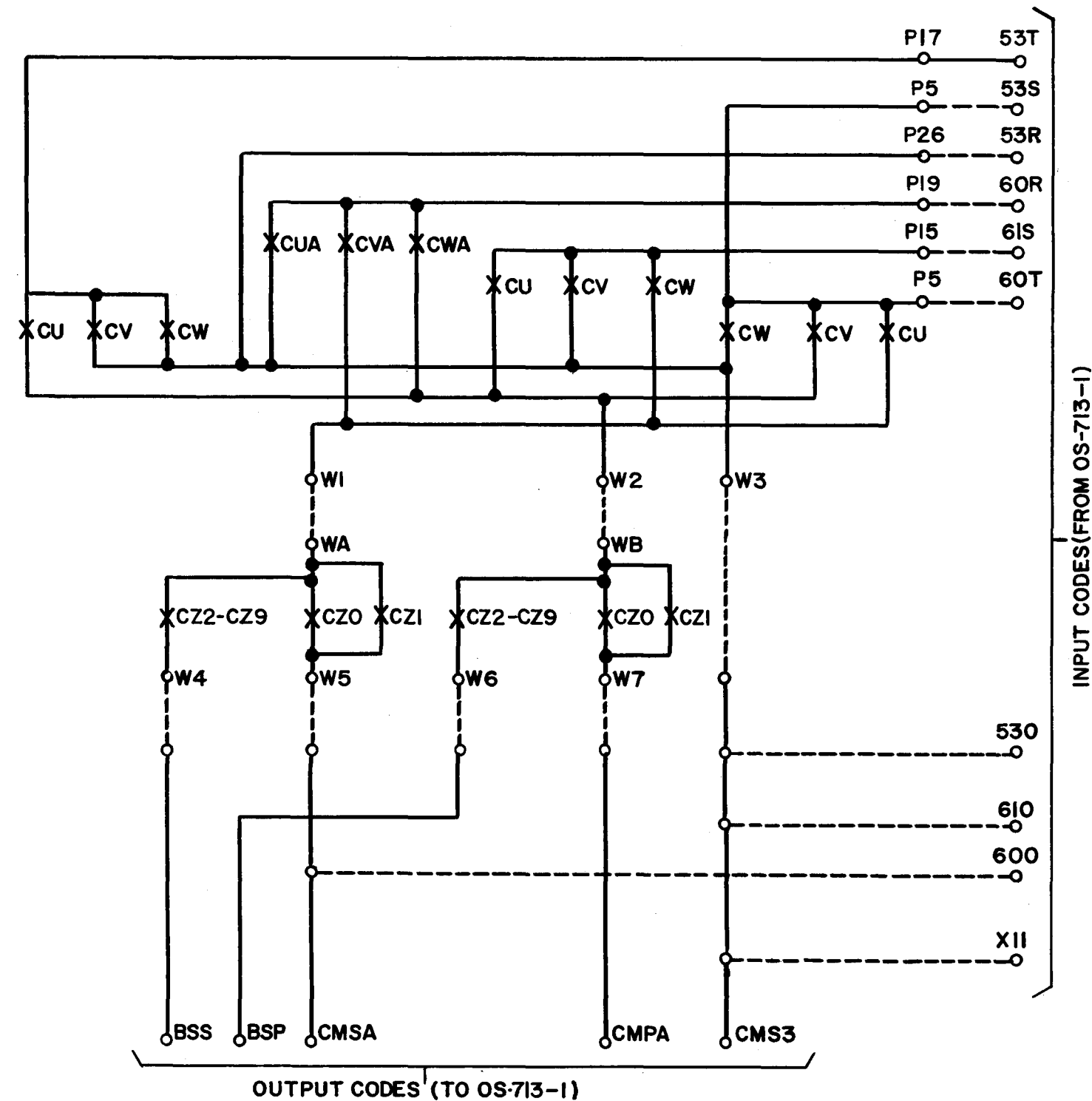
1.01 The several other features of the pretranslator, timing, trouble recorder start, second trial, etc, are discussed in detail in the circuit description - CD-25568-01.



OUTPUT CODES	
PUNCHING	REGISTER TO CALL IN MARKER AFTER
BSS	7 DIGITS
BSP	7 DIGITS AND STATIONS DELAY
CMS3	3 DIGITS (NO COIN RETURN)

INPUT CODE CROSS CONNECTIONS				
CODE	PUNCHING	ABC DIGITS	REGISTER TO CALL IN MARKER AFTER	CROSS CONNECT PUNCHING
760	530	760	3 DIGITS	760 TO CMS3(NO COIN RETURN)
761	53R	761		76R TO P26 W3 TO CMS3(NO COIN RETURN)
762		762		
763		763		
764	53S	764	7 DIGITS	76S TO PI
765		765	7 DIGITS AND STATIONS DELAY	W1 TO BSS,W2 TO BSS
766		766	3 DIGITS	W2 TO CMS3 (NO COIN RETURN)
767	53T	767	7 DIGITS AND STATIONS DELAY	76T TO PI7
768		768	3 DIGITS	W2 TO BSP
769		769		W3 TO CMS3 (NO COIN RETURN)
XII	XII	XII		3 DIGITS
VCR	VCR	---		VCR TO CMS3 (NO COIN RETURN)

FIG. 1 — TYPICAL CROSS CONNECTIONS FOR A 3 DIGIT HOME AREA



OUTPUT CODES	
PUNCHING	REGISTER TO CALL IN MARKER AFTER
BSS	7 DIGITS
BSP	7 DIGITS AND STATIONS DELAY
CMSA	10 DIGITS
CMPA	10 DIGITS AND STATIONS DELAY
CMP3	3 DIGITS (COIN RETURN)
CMS3	3 DIGITS (NO COIN RETURN)

INPUT CODE CROSS CONNECTIONS				
CODE	PUNCHING	ABC DIGITS	REGISTER TO CALL IN MARKER AFTER	CROSS CONNECT PUNCHING
530	530	530	3 DIGITS	530 TO CMS3 (NO COIN RETURN)
531	53R	531		53R TO P26 W3 TO CMS3 (NO COIN RETURN)
532		532		
533		533		
534	53S	534	7 DIGITS	53S TO P5
535		535	7 DIGITS AND STATIONS DELAY	W1 TO WA, W4 TO BSP,
536		536	3 DIGITS	W2 TO WB, W6 TO BSP, W3 TO CMS3 (NO COIN RETURN)
537	53 T	537	7 DIGITS AND STATIONS DELAY	53 T TO P17
538		538	3 DIGITS	W2 TO WB, W6 TO BSP
539		539		W3 TO CMS3 (NO COIN RETURN)
600	600	600	10 DIGITS	600 TO CMSA
601	60 R	601	3 DIGITS	60R TO P19
602		602	10 DIGITS	W3 TO CMS3 (NO COIN RETURN)
603		603	10 DIGITS AND STATIONS DELAY	W1 TO WA, W5 TO CMSA W2 TO WB, W7 TO CMPA
607	60T	607	10 DIGITS	60T TO P5
608		608	10 DIGITS AND STATIONS DELAY	W1 TO WA, W5 TO CMSA W2 TO WB, W7 TO CMPA
609		609	3 DIGITS	W3 TO CMS3 (NO COIN RETURN)
610	610	610		W3 TO CMS3 (NO COIN RETURN)
614	61S	614	10 DIGITS AND STATIONS DELAY	61S TO P15
615		615	3 DIGITS	W2 TO WB, W7 TO CMPA
616		616	10 DIGITS	W3 TO CMS3 (NO COIN RETURN) W1 TO WA, W5 TO CMSA
X11	X11	X11	3 DIGITS	X11 TO CMS3 (NO COIN RETURN)

FIG.2 -TYPICAL CROSS-CONNECTIONS FOR A 3 DIGIT HOME AREA WHERE THE HOME OFFICE IS ARRANGED FOR XOX AND XIX CODES

SECTION 5

INTRAOFFICE CALL

DETAILED CIRCUIT OPERATION

WIRE-SPRING-RELAY TYPE

INTRAOFFICE CALLS

NO. 5 CROSSBAR OFFICES

CONTENTS	PAGE
A. INTRODUCTION	4
B. ESTABLISHING THE TERMINATING CONNECTION - CALL-FORWARD LINKAGE . .	5
1. General	5
2. Originating Register Selects an Idle Marker	5
Originating Register Marker Connector - Register Part	5
Originating Register Marker Connector - Marker Part	5
Originating Register Marker Connector - Preference Control . .	6
Originating Register Connects to a Marker	6
3. Class of Service and Screening Relay Functions	8
4. Code Translation and Grounding Code Points	11
5. Operating the Route and Route Series Relays	14
6. Recording the Calling Line Identity in the Marker	16
7. Recording the Called Line Numericals in the Marker	17
8. Trunk Link Frame Selection, Preference and Seizure	18
General	18
Testing for a Trunk Link Frame With Idle Intraoffice Trunks .	18
Testing for an Idle Trunk Link Frame	18
Testing for an Idle Intraoffice Trunk	19
Trunk Link Frame Preference	19
Trunk Link Frame Seizure	20
Recycle of Frame Memory Preference	21
9. Number Group Selection, Seizure and Translation	21
Number Group Selection	21
Number Series Selection	21
Operation of Number Series Relay	22
Number Group Seizure	22
Number Group Translation	23
10. Called Line Information Transferred to the Marker	26
11. Trunk Selection	27
Trunk Blocks and Trunk Groups	27
BT Leads	28
Testing and Seizure of Idle Intraoffice Trunk	28
Test for an Idle Trunk	29
Trunk Selection	29
Preference Lockout Circuit	29
12. Release of the Number Group	30
13. Selecting the Line Link Frame - Call-Forward Linkage	30
14. Operation of the Called Line Identification Relays	31
15. Selection and Application of the Ringing Combinations	32
16. Class Information and Class Check	34
General	34
Flat Rate Call	35
Coin Charge Call	35
Message Rate Call	36

CONTENTS

PAGE

17.	Channel Test and Selection	37
	General	37
	Junctor Distribution	37
	Junctor Subgroup Selection	38
	Selection of the Group of Line Links	39
	Selection of a Group of Trunk Links	39
	Test Check	40
	Channel Test	40
	Channel Selection	41
	Channel Preference	41
18.	Select and Hold Magnet Operation	42
	Select Magnet Operation	42
	Hold Magnet Operation	42
	General	42
	Idle Check of Channel Links Before Operating Hold Magnets	43
	Hold Magnet Timing and Control	44
	Hold Magnet Operation - Light Traffic	45
	Operation of Trunk Switch and Junctor Switch Hold Magnets - Trunk Link Frame	45
	Operation of Junctor Switch Hold Magnet - Line Link Frame	45
	Operation of Line Hold Magnet - Line Link Frame	45
	Hold Magnet Operation - Heavy Traffic	46
	Dual Voltage Operation	46
	Operation of Trunk Switch and Junctor Switch Hold Magnets - Trunk Link Frame	46
	Operation of Line Hold Magnet - Line Link Frame	47
	Sleeve Crosspoint Check After Operating Hold Magnets	47
	Trunk Switch Crosspoint Check - Trunk Link Frame	47
	Junctor Switch Crosspoint Check - Trunk Link Frame	47
	Junctor Switch Crosspoint Check - Line Link Frame	48
	Junctor Switch and Line Switch Crosspoint Check - Line Link Frame	48
19.	False Cross-Ground Test	48
20.	Continuity Test	49
	Operation of the CON Tube and CON and CONA Relays	50
	Operation of the RCTA and RCTB Relays	51
21.	Ground, Loop, and Receiver-off-Hook Tests	52
	General	52
	GT1 Relay	52
	GT Relay	53
	Ground Test	53
	Loop Test	53
	Receiver-off-Hook Test	53
22.	Double Connection Test	54
23.	Release of the Select Magnets	54
24.	Linkage Check Circuit	54
C.	ESTABLISHING THE ORIGINATING CONNECTION - CALL-BACK LINKAGE	55
	1. General	55
	2. Release of Certain Relays Used in the Terminating Connection - Call-Forward Linkage	55
	3. Start of the Call-Back Linkage	56

CONTENTS

PAGE

4.	Selecting the Connecting Path to the Calling Line	56
	General	56
	Selecting the Line Link Frame	56
	Selecting the Vertical Group	57
	Selecting the Horizontal Group	57
	Selecting the Line Hold Magnet	57
	Selecting the Line Link Test Leads	57
	Selecting the Junctor Subgroup	58
	Selecting the Group of Trunk Links	58
	Test Check and Channel Selection	58
5.	Release of the Dialing Connection	58
6.	Dial Tone Lockout	58
7.	Select and Hold Magnet Operation	59
8.	Continuity Test	59
9.	Double Connection Test	59
10.	Transfer of Connecting Path Supervision to the Intraoffice	
	Trunk	59
11.	Marker Release	60
12.	Originating Register and Originating Register Marker Connector	
	Release	60
13.	Ringling the Called Customer	60
14.	Disconnect at the End of the Call	61
	Called Customer Disconnects First	61
	Calling Customer Disconnects First	61

A. INTRODUCTION

1.01 This is one of a group of sections that describes the detailed circuit operation for the various types of calls and is associated with wire spring relay type circuits of the No. 5 crossbar system.

1.02 Intraoffice calls are calls between two customers in the same office or between two customers in different offices that are served by the same marker group. They are described in six stages:

- (1) Establishing the dialing connection.
- (2) Dialing the called number.
- (3) Establishing the call-forward linkage or terminating connection.
- (4) Establishing the call-back linkage or originating connection.
- (5) Ringing the called customer.
- (6) Disconnect.

Fig. 1 shows the circuits engaged in completing the above stages.

1.03 Stage 1 above is contained in the section that describes the circuit operation for establishing the dialing connection. During this stage, an originating register is selected and connected to the calling line by a dial tone marker.

1.04 In stage 2 the complete called line directory number is dialed into the originating register. When dialing is completed, the originating register seizes a completing marker.

1.05 In stage 3 above, the marker selects an intraoffice trunk and connects it to the called line. By connecting to the called line before connecting to the calling line, the marker is able to make an early test to determine if the called line is busy. If it is busy, the calling line is immediately connected to a tone trunk. Making the busy test early in the call saves needless marker operations on calls to busy lines, thereby reducing average marker holding time.

1.06 In stage 4 above, the marker connects the intraoffice trunk to the calling line. At the end of this stage, the marker and the originating register are released.

1.07 The connection for ringing the called customer is set up by the marker at the end of stage 3. The actual ringing, however, is delayed until the end of stage 4. This prevents premature ringing if a delay is encountered in establishing the originating connection.

1.08 When the called line is one of a group of lines comprising a PBX group, it is possible for the call to be completed to any idle line in the group. The selection of an idle line in a PBX group is called PBX terminal hunting.

B. ESTABLISHING THE TERMINATING CONNECTION - CALL-FORWARD LINKAGE

1. General

- 1.01 Establishing the terminating connection consists of the selection of an intraoffice trunk and the connection of this trunk to the called line.
- 1.02 When the calling customer has finished dialing, the originating register seizes a completing marker. The register then transfers to the marker the class of service of the calling line and the dialed digits of the called number. The marker uses this information in the following ways:
- (a) From the class of service of the calling line, it determines what type of trunk is needed for charging purposes (for example, flat rate, message rate, coin, etc.).
 - (b) From the office code of the called line number, it determines that the call is intraoffice.
 - (c) From the numerals of the called line number and from the number group circuit, it determines the equipment location of the line and the type of ringing that is required.
- 1.03 The marker then selects and seizes an intraoffice trunk for the required class of service by connecting to a trunk link frame. The terminating connection is then established from the B appearance of the trunk to the called line.

2. Originating Register Selects an Idle Marker

Originating Register Marker Connector

- 2.01 An originating register requiring the services of a marker to complete its call gains access to a marker through the originating register marker connector, register part, thence through an originating register marker connector, marker part, and thence through to the marker.
- 2.02 Register Part of Connector: One originating register marker connector, register part, is paired with one originating register marker connector, marker part. The register part is provided with one group of wire spring multicontact relays and one preference relay per register. The passage of information from the originating register to the originating register marker connector, marker part, and then to the marker are provided by these multicontact relays. One preference relay per register is provided to establish a preference for registers competing for the same connector.
- 2.03 Marker Part of Connector: One originating register marker connector, register part, is paired with one originating register marker connector, marker part. The marker part is provided with one group of wire spring multicontact relays per marker. The passage of information from the register part of the connector to the marker are provided by these multicontact relays. The connection through the originating register marker connector, register and marker part, is held as long as the connected register requires the marker, and during this time the other registers associated with this connector may not gain access to a marker.

2.04 Originating Register Marker Connector Preference Control Circuit:

In each marker connector there is a preference control circuit consisting of a marker start relay MS and marker busy relay CB for each marker. It is the purpose of these relays to give each connector access to the first idle marker depending on the connectors preference position and to make the marker busy to all other connectors, to operate connector relays which will close all the necessary leads between the marker and the originating register, and by means of cross-connections in the markers to vary the order of preference of connectors for markers.

2.05 Originating Register Marker Connector Control Circuit: Each connector also has a control circuit which in connection with the master traffic control circuit and the frame traffic control serves to equalize the service given to the several connectors in a group. This is done by gating the connectors (holding the start leads open) after they are once used if other connectors are being served at the same time. Therefore a connector will not be served a second time until other connectors calling for markers have been served once.

2.06 This type of connector is called a double-ended connector because one of several circuits of one type on one end of the connector seeks one of several markers on the other end. Refer to Fig. 2 for a typical multiple arrangement of the originating register and the originating register marker connector frames.

2.07 A number of originating registers share one marker connector. Therefore, any originating register that attempts to seize its connector must compete with the other originating registers served by this same marker connector. If the originating register marker connector is busy, the originating register waits until it is idle before it proceeds. This is necessary because no alternate originating register marker connector is provided.

Originating Register Connects to a Marker

2.08 The first operation in stage 3 is marker seizure by the originating register. This is controlled by the register preference start feature in the connector.

2.09 There is one RS (register start) relay per register in the register part of a marker connector. The circuit is arranged so that if one or more RS relays operate, only one set of register connector multicontact relays operates at one time. These RS relays are wired in a preference chain in which contacts and wiring are multiplied to insure against open circuits which might put the entire marker connector out of service. The winding of the RS relay for the register, which is assigned last preference, is connected directly to ground (FS-1, FS-2, FS-3, SD-26024) (OS 701-2).

2.10 When a register is ready to seize a marker, its MST (marker start) relay operates. This operates the RS relay which operates the associated multicontact relays RA through RE. If other registers call for a marker while their connector is busy, their RS relays may also operate. However, the operating path for the multicontact relays of these registers is opened by the operated RS relay of the engaged register.

2.11 The RS relay for the last preference register is connected directly to ground and it may operate at any time. When it does, operating ground for all the other RS relays is removed. However, if some less preferred RS relay is operated, its locking ground is extended toward the more preferred relays. This provides operating ground for these relays. If the first preferred RS relay is the first one operated, it is possible for all the other RS relays in the chain to operate. As each RS relay operates, it locks and waits its turn for the preference chain ground to operate its multicontact relays. The ground circuit starts at the first preferred RS relay and progresses toward the last preferred relay.

2.12 After the RC relay operates, battery is connected to start leads STA and STB and extended through the preference control circuit to the MSA or MSB punching (FS-1, SD-26029) (OS 701-2). The two relays of the W and Z combination in the marker connector control circuit determine which one of the two start leads is closed through the marker connector control CB- (chain busy) relay (FS-2, SD-26029) (OS 701-2). Over this particular lead an MS- (marker start) relay associated with a marker is operated. The operation of the W and Z relay combination and the CB- and MS- relay chain circuits described in the dial tone job also applies here, except for the following differences:

(a) W and Z Relay Combination: Ground is applied to the W relay through the MC (marker connector) relay. When the marker is ready to disconnect, it causes the operation of the MRL (marker release) or BT (busy tone) relay in the originating register (FS-2, SD-26023, FS-4, SD-26024, FS-5, SD-26040). This removes battery from the ST lead, which releases the MS- relay. Relay MS- causes the release of the MA through ME relays (FS-1, SD-26023). Relay MC removes the ground, shunting relay Z (FS-4, SD-26029).

(b) MS- (Marker Start) Relay Chain Circuit (OS 701-2): Both originating register marker connectors and incoming register marker connectors are competing for completing markers through the same MS- relay chains. An MS- cross-connection punching is provided per CB- relay. Punchings MSA and MSB for each connector are cross-connected to two of these MS- punchings. A marker associated with an MS- punching connected to an MSA or MSB punching is a first choice marker for the originating register and incoming register marker connector from which the start lead originates. Since there are two start leads, each frame has two first choice markers. The start lead that is connected through the marker connector control circuit determines which of these two markers is the first choice on a particular usage. The arrangement of the cross connection is such that each marker is first choice for about the same number of connectors.

(c) CB- (Chain Busy) Relay Circuit (OS 701-2): A particular start lead that is connected through the marker connector control circuit applies resistance battery to the punching to which it is connected. If the marker associated with this punching is busy serving another connector, relay CB- is operated. Resistance battery is then passed to the next CB- relay in the chain. Assume that the resistance battery is finally connected to a released CB- relay associated with an idle marker. This battery then operates and locks the MS- relay (in preference control circuit) associated with the idle marker. The CB- relay locking ground is provided by the operated RC relay in the originating register marker connector, register part (FS-4, SD-26024, FS-3, SD-26029).

2.13 The operation of relay MS- operates multicontact relays MA through ME (marker connector), thereby seizing the marker. The operation of relay MA shunts relay CB- in the seizing preference control circuit associated with the seized marker. Relay MD operates relays MCB- (marker connector busy) in the marker. These relays apply ground to all of the CB- relays associated with the seized marker in all preference control circuits, operating all but the shunted one in the seizing connector. Relay MS- in operating also releases the marker connector check relays, MAK, MCK, and MSK in the marker. The release of any one of these relays operates relay TM, which starts marker timing. A check for the marker seizure is indicated by the operation of the marker CKG1 and CKG2 relays. These relays provide battery, ground, and the interconnections necessary for the marker to operate.

2.14 The connector is prevented from reverting to a more preferred marker by locking operated those CB- relays in the connector corresponding to busy markers at the time a seizure is attempted. The locking ground is provided immediately by relay TM (timing), and later by relay RC (marker connector). It is connected in such a way that at least one CB- relay must be normal to enable the ground to lock those that are operated. This is necessary to prevent a call from blocking itself if a temporary all-markers-busy condition is encountered.

2.15 There is a time interval between the operation of relay MS- in the seizing preference control circuit and the operation of relays CB- in all of the other preference control circuits. During this interval other connectors may also operate MS- relays associated with the same marker. These MS- relays, however, would be in less preferred connectors than the first connector to succeed in operating its MS- relay. Because of the arrangement of the chain circuits controlling the operation of the MA relay, the highest preference connector, with relay MS- operated, always succeeds in seizing the marker. The subsequent operation of CB- relays in other connectors transfers their start leads to other markers, releasing their MS- relays associated with this marker.

2.16 On an attempt by two connectors to seize the same marker, the one with a faster operating MS- relay always succeeds. In order to prevent a particular connector from being served repeatedly while others are forced to wait, a system of traffic control is provided. Traffic control is described in CD-26029-01.

2.17 After the marker is seized, the calling line class of service, the called line office code and numerals, and the calling line identification are passed from the originating register to the marker.

3. Class of Service and Screening Relay Functions

3.01 When a marker is trying to do a job (intraoffice call for instance) one of the several things it must consider is the calling subscriber's class of service. Obviously, if the subscriber is using a coin telephone, the marker has to choose a trunk with coin charging features. If the subscriber happens to be a message rate subscriber, it must pick the right kind of intraoffice trunk for this service.

3.02 During the dial tone job, the dial tone marker determined the class of service of the calling subscriber and then passed it to the originating register. After dialing was completed, the originating register connected to the completing marker and passed the subscriber's class of service to the marker. On SD-26002, FS-10 we see the details of this transfer. The tens digit of the class of service operates one of the CTO, 1 or 2 relays. The operated CT- operates a CTA0, 1 or 2 and if provided, a CTBO, 1 or 2. The units information is passed to the CUA- and the CUB- relays if they are provided, two out of five CUA's and two out of five CUB's operate for the class of service units. There are two sets of class of service relays. One set handles thirty classes in the A group, the other thirty classes in the B group. The marker is equipped with the A group and an option will add the B group relays. With this option we can have sixty classes of service in a marker group. Because any class of service operates tens and units relay in the A group and, also tens and units relays in the B group, a control or separator is provided. The control which separates a class of service in one group from a class in the other is the CGA and CGB relays shown on FS-10. The CGA relay indicates one of thirty classes of service in the "A" group and the CGB indicates one of thirty classes of service in the "B" group. Each class of service in either "A" or "B" group is represented by a punching SWC-. There are thirty SWC's numbered 0-29 in each group. These punchings are connected to the windings of screening relays according to assignments for class of service. The reason for providing so many classes of service is that in large marker groups which consist of two or three central office designations, classes of service are distinguished, in the various offices, for charging purposes.

3.03 Each completing marker has an assortment of screening relays. They are used to control the marker routing of calls made by the various classes of service. These relays are assigned to the classes of service by cross-connection assignments. On OS 714-1, Sheet 1, there is a sketch which shows how the class of service information passes from the originating register to the completing marker. We can see how each class of service is represented by a punching SWC-. The tens and units relays for each class of service apply ground to one of the thirty SWC punchings. These SWC- punchings are cross-connected to the windings (SW- punchings) of screening relays according to assignments for class of service. On OS 714-1, there is one example (class of service 07) of how each SWC- punching is grounded. Each other class of service punching is grounded in a similar way.

3.04 We can see on OS 714-1 how this ground operates screening relay S07 through the cross connection. Also on the right side of the sheet, a similar circuit shows us that one will operate a second relay S31. We have two screening relays operated for this one class of service. They will provide us with many contact points or paths so that we can "screen" this class of service and give it the proper treatment for our call.

3.05 The assignment of S- relays to classes of service is arbitrary. We have assigned two relays S07 and S31 to class of service 07. If our central office happened to be larger, if it had many more divisions of class of service than we have on OS 714-1, then we would need more than two S- (screening relays) for each class of service. The different classes of service shown on the sketches are typical of those found in many central offices. Because the charges on many routes vary for two similar classes of service in the two

offices, the class of service in Office B (Podunk 6) are assigned different screening relays than their counterparts in Office A (Podunk 5).

3.06 In this series of operational sketches and in the series on route relay operation the material is presented as though it were engineered for an existing central office unit. On OS 714-1, Sheet 1, there is a chart which describes the assignments of the typical classes of service of two central offices, Podunk 5 and Podunk 6. These are two physical central offices in one marker group and represent Office A and Office B. Typical arrangements of assignments and cross connections are presented on these sketches.

3.07 The relays shown on OS 714-1, Sheet 1, are under the heading "Class of Service Grouping - Group A." This means that this arrangement represents a completing marker equipped for either thirty or sixty classes of service, and in either case, this is the "A" group. The group is divided into two sorts. In sort 1, each class of service is assigned an individual screening relay. These relays will be used for the routes where subscribers with different class of service receive different treatment. In sort 2, some classes of service share a screening relay. For example, Podunk 5 subscribers with the service PBXF, IF and 2F all use screening relay S28. This is done to cut down on cross connections. Since for various outgoing routes these classes of service relays get the same treatment, we can cut down considerably on our use of S- relays and cross connections through this arrangement.

3.08 Screening relays S08, S09, ³²S31 and ³³S32 are for trunk classes of service where toll and tandem switching features are provided. These features are discussed in another section of the text under Toll and Tandem Switching features.

3.09 On Sheet 2 of OS 714-1, we have a sketch of two sets of screening relays S00-03 and S116-119. These represent the first four and last four respectively of all the screening relays provided in the completing marker. Screening relays S00, S01, S02 and S03 have their contacts multiplied so that they form a unit. Each successive group of four screening relays are wired as a unit in the same way. The table on this page shows at a glance how the relays are divided into groups, four relays to each group.

3.10 The left side of the S relay contacts are multiplied and connected to USC punchings. For example, punching USCO is common to number one contact of S relays 00, 01, 02 and 03. However, the other side of these contacts of the relays appear as twelve separate punchings so that we can make individual connections as they are required. For instance if we connect a circuit to punching USCO, then we have four possible paths we can follow depending on which S- relay is operated. If we assign four classes of service to these four relays, we can give them individual treatment by continuing the paths from SO punchings of the four relays to the desired points. This arrangement is called "screening." In selecting S- relays for assignment to classes of service, we take as many groups of four S- relays as are required and connect their associated USC- punchings. For instance, in our marker group, we have ten classes of service in Podunk 5 (eight subscriber classes and two trunk classes) and eight classes in Podunk 6. This gives us a total of eighteen classes. Five groups of S- relays (S00 to S07 and S20 to S29 inclusive) have their associated USC- punchings connected.

3.11 Sheet 3 of OS 714-1, is a reproduction of the standard marker cross connection form which is used for class of service discrimination. Most of the items, which appear on the form apply to the route relay sketches, OS 716-1. These are discussed later in this section. However, we can see some of the assignments pertaining to class of service and S- relays on this sheet. For example, at the top of the sheet we have the classes of service appearing as column headings. They are grouped into central office heading PO 5 (Podunk 5) and PO 6 (Podunk 6). Immediately under these, we have the service relay or screening relay numbers assigned to these classes of service. In the middle of the sheet we have a division - "service relay NO." Across the sheet appear the S- relay numbers 28, 29, 30, etc. Relay number 28 is used for classes of service 00, 01 and 02. This agrees with the cross connections and the table on Sheet 1. We can see that the top part of the form pertains to the service (or screening) relays in sort 1 as shown on Sheet 1 of this OS. The bottom half of the form shows those service relays in sort 2. The marker cross-connection form is offered so that the student can become familiar with the method of presenting the assignments for these cross connections. The assignments, as written in this form, apply to our fictitious central offices, Podunk 5 and Podunk 6. The details of these assignments as they appear on this form, will be discussed under route relay cross connections.

3.12 On calls made by a 2-party line, the originating register determines which party is calling. It passes the results of the test to the completing marker. Either the TP relays or RP relays operate on 2-party calls. The marker must determine which party is calling for proper charging of the call. It is possible to give two parties of a line different service. For example, we might allow the ring party to have flat rate service, and the tip party message rate service. This is done by assigning separate S- screening relays to the two parties. On SD-26002, FS-11 there is a group of punchings, SWPO-3. These punchings are cross-connected to the SWC- punchings representing 2-party lines. The other side of the TPA and RPA screening contact field, appears as SWT 0-3 and SWR 0-3 punchings. The SWT 0-3 (on TPA or TPB relay) or SWR 0-3 (on RPA or RPB relay) punchings are cross-connected to the SW- punching according to class of service cross-connection assignments. With this cross-connection arrangement, the two parties have individual S- (screening) relays. We can use the screening relay paths so as to give separate charge conditions for each of the two parties.

4. Code Translation and Grounding Code Points

4.01 When the originating register connected to the completing marker through the marker connector, it passed to the marker all the information about this call. Three pieces of information were the A, B and C digits which the subscriber had dialed. These three digits represent the central office code of the called subscriber. The marker examines these digits one at a time beginning with the "A" digit. It uses these digits to place ground on a punching which represents the dialed central office code. This punching is called a code point. A code point has a number which represents the digits (or letters) for which it stands. The process which the marker performs in trying to ground the proper code point is called code translation. This part of the text describes how the marker performs this operation. An example using one of the intraoffice codes will be followed.

4.02 Let us assume that our calling subscriber dialed a telephone in his own central office. The number, which he dialed, is Podunk 5 1234. The marker is not interested in the telephone number - 1234 at this time; the marker will look at it later. At this time the marker is concerned with the A, B and C digits 765- for Podunk 5. We can use the sketches of OS 715-1 to see what takes place.

4.03 On Sheet 1, we have the ACO and 7, BCO and 7, CCO and 7 digit register relays. They represent the whole complement of ACO, 1, 2, 4, 7, BCO, 1, 2, 4, 7, and CCO, 1, 2, 4, 7 relays which store the central office code. For our call, the dialed code is 765- (Podunk 5). The ACO and 7, BC2 and 4, CC1 and 4 relays would be operated.

4.04 Also the LT (local translator), OR (originating register call), PK (no partial dial - no permanent signal check) and SCK (no stuck coin check) relays are operated by grounds from the originating register. Since the first digit is a "seven" 765-(PO5) the AT-7 ("A" digit translator number seven) relay should operate. We can trace the ground from normal contacts of the XT relay (crossed translator indication) through operated CKG 2 and OR, normal FAC and through two checking circuits. One of these checks for false coin signals from the register, the other for false timing signals (permanent signal time-out, partial dial time-out). Our circuit continues through operated PK, normal SCN, operated OR to the two-out-of-five "A" digit checker. If we have anything other than two AC relays operated, the call is blocked. This prevents translation attempts when "crossed" or "false" "A" digits are received. The path goes on through operated ACO and AC7, operated LT contacts, through the LTA7 to ATW7 cross connection and winding of AT7 relay. So far we have translated the A digit. The LT (local translator) relay indicates to the marker it must translate three digits A, B and C in order to ground the proper code point C765. Of course at this moment the marker doesn't know which code point it will ground. This is what it's trying to find out in the code translation process.

4.05 On Sheet 2 we find the translation circuit for the "B" digit. Since our "B" digit can be any of the letters on the dial, it follows that it will be one of the numbers 1 through 9. There are three auxiliary translator relays on this sketch. They are BL47, which represents the "B" digits 1, 4 and 7, B369 (for "B" digits 3, 6 and 9), and B258 (for "B" digits 2, 5 and 8). Since our "B" digit is a "6" (765,PO5), the B369 relay operates. The path is through operated BC2 and BC4 and the two-out-of-five "B" digit checking circuit. This same ground is also connected to the contacts of the BC relays of the translator. We can move this ground through the operated BC2 and BC4, operated AT7, through the AT76 to BT7S cross connection. This will operate "B" digit translator relay BT7S.

4.06 A word about the method of translating the "B" digit before we go on with this call. There are one thousand possible codes if we consider the digits 0 to 9 for A digit, 0 to 9 for B digit and 0 to 9 for the C digit (10 x 10 x 10). Codes which have an "0" in the B digit are used for customer national toll dialing and these are discussed later in this section. There are one hundred of these codes which have a zero in the B digit. The remaining nine hundred codes are translated by thirty multicontact relays which have thirty contacts each (30 x 30 = 900). These relays are named BT- for "B" digit translator. They are numbered according to the "A" digit which they

represent and lettered according to the "B" digits which they translate. The letters used are "R", "S" and "T". "R" stands for the B digits 1, 2 and 3. "S" stands for 4, 5 and 6. "T" stands for 7, 8 and 9. Relay BT4R, for example, represents those codes which have a four in the "A" digit and either a one, two or three in the "B" digit. Relay BT6S represents those codes with a six in the "A" and either a four, five or six in the "B" digit. Relay BT5T represents those codes with a five in the "A" and either seven, eight or nine in the "B" digit. The arrangement used in translating the "B" digit is similar to the translation of the "C" digit in the pretranslator. In translating the "B" digit, the marker divides the nine possible digits (one to nine) into three groups, R, S and T and then divides them again using the auxiliary relays B147, B258 and B369. We can readily see in Table A how this double-division splits the "B" digit so that with two references, namely R, S, or T and one of the three auxiliary relays, we have an exact definition of the "B" digit.

TABLE A

"B" DIGITS

9		
	8	"T" DIGITS
	7	
6		
	5	"S" DIGITS
	4	
3		
	2	"R" DIGITS
	1	
B369	B258	B147
RELAY	RELAY	RELAY

4.07 We have operated BT7S on this call. This relay stands for all the codes which have a seven for an "A" digit, a four, five or six for a "B" digit and anything from zero to nine for a "C" digit. This arrangement gives us a total of thirty codes (1 x 3 x 10). The codes handled by BT7S are 74-(0-9), 75-(0-9) and 76-(0-9). Our code, 765, falls in this category. Of course, the operated B369 relay has split this division by a third so that we now have narrowed our possible codes to ten, BT76 (0 to 9). Up to this point, we have translated the "A" digit (operated AT7) and have translated the "B" digit (operated BT7S).

4.08 On Sheet 3, we have the translation circuit for the "C" digit. Starting with the ground through the CKG2 contacts, we pass through the "C" digit checking circuit (through CC1 and CC4 operated) through operated contacts of CC1 and CC4 again operated contacts of B369 relay to a multiple of number fifty contact of all thirty BT-- relays. However, only one of these BT7S, is operated. This contact is wired to a punching which is identified as code point C765. This code point represents the ABC digits 765 for PODunk 5.

4.09 The "C" digit translator circuit on Sheet 3 is divided into nine fields of one hundred codes each. The codes in any one of these fields all have the same "B" digit. For instance, our code C765, falls into the top center group or field. These one hundred punchings are indicated as "X6X" codes. This means those codes which have a six in the "B" digit, but various "A" and "C" digits. Relays BTOS to BT9S (ten relays) each has ten contacts in this field (10 x 10 = 100 code points).

4.10 Various other examples are shown on this OS. Some are identified and some are not. Each one can be identified as an exact code punching having a 3-digit number.

4.11 The translation of one and 2-digit code points is discussed in a different section of this text.

5. Operating the Route and Route Series Relays

5.01 So far in the progress of our call, the marker has grounded the code point, C765, which represents the called central office, Podunk 5. We have defined this call as an intraoffice job, however, at this time there is no indication as to what kind of a job it is to perform. It must first operate a route relay; this relay will give the marker information about the kind of call.

5.02 On OS 716-1, Sheet 2, we have a typical sketch of route relay cross connections for intraoffice routes. In the marker group we have been discussing, we have two central offices, Podunk 5 (Office A) and Podunk 6 (Office B). We have been provided with various classes of service which are described on OS 714-1. Also we have been given three different kinds of intraoffice trunk circuits. One of these (SD-26060-01 for instance) is equipped to handle calls by flat rate customers. By this we mean those subscribers who can make an intraoffice call free. Another trunk (SD-26061-01) is equipped to handle message rate subscribers using automatic message charging equipment. These subscribers are those who pay a charge for each time unit of a call, even on intraoffice calls. This trunk is equipped for charging these calls. Another group of trunks for intraoffice traffic are those with coin features. These trunks must be able to time calls and summon the common coin control equipment when coin subscribers make intraoffice calls.

5.03 While there are other arrangements of intraoffice trunks, the choice of separate trunk groups for these three major divisions of class of service was elected in our office. Separate trunk groups for flat rate, message rate and coin subscribers is the arrangement shown on OS 716-1, Sheet 2. This arrangement is typical of most No. 5 crossbar offices.

5.04 On this sheet we can see the code point C765 for Podunk 5, which the marker has just grounded. Since C765 represents Office "A" it is cross-connected to the LPA (local physical "A" central office) relay winding. Likewise, C766 for Podunk 6, is cross-connected to LPB for local physical "B" central office. Actually there are four more relays similar to these two. They have been left off this OS for the sake of simplification. It is possible, ultimately, to divide a marker group into six central office subdivisions. They are Office "A" physical (LPA), Office "A" theoretical (LTA), Office "A" extra-theoretical (LEA), Office "B" physical (LPB), Office "B" theoretical (LTB), and Office "B" extra-theoretical (LEB). All six relays are provided in each completing marker. Only those relays which apply to our particular office need be used. And so, on these sketches since our marker group contains two physical central office units, we only show the LPA and LPB relays.

5.05 When the LPA relay operates, it places a ground on an associated APR punching. This punching is shown cross-connected to an isolated punching SC03. There are ninety-six of these SC- punchings provided in each completing marker. They are used as "tie points" - a means of bringing two terminals together through cross connections when the punchings being connected are not on the same or adjacent terminal strips. The USC- punchings are located on the rear of the S relay unit in the marker frame. They are wired to SC- punchings according to the assignments for class of service screening relays.

5.06 In this sketch we also notice that four groups of S- relays (four S- relays in each group) have their number four contacts multiplied through the USC03 to USC03 cross connections. As discussed in the test on screening relays, we assign one or more S- relays to each class of service. Since there is a total of sixteen subscriber classes of service in our two central offices, we bridge sixteen S- relays as shown on this sketch. In fact all the other contacts are bridged in a similar manner. We will run into the remainder of these paths as we study the various marker jobs with their different route relay arrangements. For the present we are concerned only with punching USC03 and its paths through number four contact of the screening relays shown. Actually, there are four more S- relays (S08, 09, 10, 11) connected to this group. Relays S08 and S09 are for trunk classes of service. Relays S10 and S11 are spare. The connection to these relays can be ignored when studying intraoffice routes because there aren't any cross connections on their associated S3 punchings.

5.07 If we assume on this call, that our calling subscriber has the class of service number 01, which is individual flat rate in Podunk 5, then screening relays S01 and S28 would be operated. At the present time we are only concerned with screening relay S01. One set of its contacts provide us with a path for operating our route relay R10. The individual contact of our screening relay appears on a punching S3. This punching is cross-connected to a grouping punching SG00. There are sixty of these grouping punchings SG00 to SG59. They are used as a convenient place for connecting various wires which must all connect to a common point. In this case the ultimate point or punching is RC10, however, it wouldn't be practicable to bunch all eight cross-connections from the eight S3 punchings to one punching RC10. So we use the SG- punchings. The assignment of these SG- punchings is arbitrary. For the purposes of keeping the record straight on these sketches, there is a table on OS 714-1, Sheet 3 which list these assignments.

5.08 Since we have three different groups of intraoffice trunks in our office - flat rate, message rate (AMA) and coin - all those subscribers which have flat rate service of one kind or another, use the R10 flat rate intraoffice route relay. All those subscribers having message rate service use route relay R21 - intraoffice message rate (AMA) trunks, and the coin subscribers use R20 - intraoffice coin trunks. These route relays control the marker's selection of their own group of trunks. This is discussed in detail under trunk selection.

5.09 The path for operating route relay number R10, our example, was through operated contacts of S01 relay, the S3 to SG00 cross connection, the SG00 to RC10 cross connection, winding of R10 to winding of a route series relay NCNC. The purpose of a route series relay is to indicate to the marker something about the charge condition for the call. Relay NCNC means there will be no charge and the calling subscriber is not a coin class of service. However, if we choose a message rate subscriber, such as Podunk 5, 2-party message rate, we have a different condition. The screening relay for this subscriber is S06. The S3 punching is connected to SG01 which in turn is connected to RC21, the intraoffice AMA route relay in series with relay MBS1. The MBS1 relay stands for "message billing index number 1." This is a signal which the marker will pass on to the automatic message accounting equipment later on in the intraoffice call. Of course, if the office is not equipped for AMA then some other charge relay is assigned instead of MBS1. If the subscriber making the intraoffice call happened to be a coin subscriber on Podunk 5, then S07 screening relay would be operated. Its S3 punching is cross-connected to route relay R20 in series with TCNC. Relay TCNC means talking charge but not a coin subscriber. At first this might seem contradictory because, in fact, we said our calling subscriber was coin. However, the trunk we are using, SD-26064-01 is designed for coin traffic only and does not require a "coin" signal.

5.10 On OS 714-1 Sheet 3 - the marker cross-connection form - we can see how the route relay cross connections for the intraoffice routes appear. On the left of the form under "assignment," we can find an item "intraoffice." In the next column under punching, we see the punchings APR and BPR which we used on the intraoffice route relay sketch. APR and BPR are cross-connected to SC03. The individual connections from the S3 punchings of the different class of service S- relays are read across the page. For example, PBXF has its S3 punching cross-connected to SG00. We can verify this by looking at the intraoffice route relay sketch OS 714-1, Sheet 2.

5.11 Now that the marker has operated a route relay assigned to intraoffice trunks, it is prepared to operate the marker class (job) control relays. On OS 716-1, Sheet 2, we see the NSI (no sender intraoffice) relay. The NSI punching for this relay is cross-connected to the OS 10, OS 20 and OS 21 punchings of the intraoffice route relays. On FS-32, we can see that the operation of NSI will operate the marker class relays ITR1 and ITR2. These marker class relays control the marker functions related to the intraoffice call.

6. Recording the Calling Line Identity in the Marker

6.01 The calling line identification must be passed from the originating register to the marker. When relay OR operates (FS-21, SD-26002) after the seizure of the marker, it operates the GTL (ground transmitting leads)

relay (FS-57, SD-26002). This operates relay GTL2. These relays operate all of the line identification relays in the marker with the exception of the CUA-, CUB- (class units), CT- (class tens), and LL- (line link) relays. The CUA-, CUB-, and CT- relays were operated previously on the class-of-service transfer. The LL- relays are operated during the call-back stage of the call. The identification relays supply the following information about the calling line (FS-1, SD-26002):

<u>Marker Relays Operated</u>	<u>Information Transmitted</u>
FT 1/4 and FU 2/5	Line link frame number
VG 2/6	Vertical group number
HG 2/5	Horizontal group number
VF 1/5	Vertical file number

This information, however, is not used until the originating connection is made to the calling line.

7. Recording the Called Line Numericals in the Marker

- 7.01 The numerical registration of the called line number is obtained from the last four digits (D, E, F, and G) of a 7-digit directory number.
- 7.02 The numericals of the called directory number are recorded on a two-out-of-five basis on the D-, E-, F-, and G- relays in the originating register. In addition, the register grounds two out of the five leads of each group D, E, F, and G. With the operation of the originating register marker connector relays RB and MB, these grounds are extended into the marker.
- 7.03 The marker determines which of the digits of the called number are the office code and which are the numericals. To indicate this for a 7-digit called number, the N4 (number translator cut-in) relay operates.
- 7.04 The operation of one of the relays LPA (local physical A), LPB (local physical B), LTA (local theoretical A), LTB (local theoretical B), LEA (local extheo A), or LEB (local extheo B) with relay LT operated grounds the NSL punching (OS 720-1) (FS-81, SD-26002). This punching, cross-connected to the N4 punching, extends ground to cause the operation of relay N4. This relay closes the path for the TH- (thousands), HN- (hundreds), T- (tens), and U- (units) relays which operate on a two-out-of-five basis to register the numerical digits of the called line. The operation of relay N4 also operates relay NE (number end) (OS 720-1). This relay checks if any of the RIA (regular intercept auxiliary), TBIA (trouble intercept auxiliary), or BNA (blank number auxiliary) relays have operated falsely and caused the operation of relay XN (cross in called number figures) (FS-63, 66, SD-26002).

7.05 If the called number is not a 7-digit number, then the translator cut-in relays (OS 720-1) are cross-connected to operate as follows:

<u>Called Number</u>		<u>Cross- Connection Punching</u>	<u>Number Translator Cut-in Relays Operated</u>
<u>Number of Office Code Digits</u>	<u>Number of Numerical Digits</u>		
None	4	NSL to N1	N1
1	4	NSE to N2	N2
2	4	NSF to N3	N3
3	4	NSF to N4	N4

8. Trunk Link Frame Selection, Preference, and Seizure

General

8.01 When the marker is directed to do an intraoffice trunk job, it tests for an idle trunk link frame that has access to one or more idle intraoffice trunks. Only one marker has access to a particular trunk link frame at one time. Therefore, it is necessary to select an idle trunk that is associated with a frame that is not connected to another marker. When such a frame is found, the marker operates the connector relays to seize it.

8.02 To prevent marker delays, the trunk link frame used for this call is seized before the number group is seized. A delay would occur if a marker was allowed to seize the number group first and then encountered an all-trunks and/or an all-trunk link frame busy condition.

Testing for a Trunk Link Frame With Idle Intraoffice Trunks

8.03 There is one FTC- (frame test common) relay per trunk link frame in the marker. There may be ten if an office contains ten or less trunk link frames or twenty if an office contains ten or more trunk link frames. These FTC- relays are connected to R- (route) relay contacts and are common to all route relays under control of the ground supply relays and terminate on FTC- punchings in the trunk link circuit. The FTC- punching associated with the intraoffice route relay is cross-connected to the FT-- punchings that are associated with intraoffice trunks. If at least one trunk is idle, it grounds its FT lead, thus grounding the FTC- lead operating the associated FTC- relay in the marker. The operated FTC- relay indicates an idle trunk on that particular trunk link frame. If no trunks are idle, the test lead is not grounded and the corresponding FTC- relay remains released. Relay FTCK (frame test check) operates to indicate that one or more FTC- relays are operated (FS-20, SD-26002) (FS-1, SD-26032) (OS 702-2).

Testing for an Idle Trunk Link Frame

8.04 Before the marker can select a trunk link frame having idle trunks it must first check that the trunk link frame is not being used by another marker. The operation of the marker off normal TLC1, trunk link control relay, operates the BCO and BC10, busy cut-in relays. The BC10 relay is provided when an office has more than ten trunk link frames. Relay BCO extends the windings

of the frame busy FBO-9 relays to their associated trunk link connectors over the FBO-9 leads and relay BC10 extends the frame busy FB10-19 relays to their associated trunk link connectors over the FB10-19 leads. If the trunk link connector is busy the corresponding test lead is grounded and the associated FB- relay will be operated. Idle trunk link frames are indicated by normal FB- relays (FS-23, SD-26002) (OS 702-2).

Testing for an Idle Intraoffice Trunk

8.05 When looking for an idle trunk, the marker tests a maximum of 20 intra-office trunk circuits on any one trunk link frame at one time. However, in some offices, two subgroups each consisting of 20 intraoffice trunks may be associated with one trunk link frame. Therefore, the 2-step allotter is provided so that the marker may select one of the two groups for testing.

8.06 When the 2-step allotter is not required the intraoffice route relay operates under control of the grounded code point and class screening relays (OS 716-1).

8.07 When the 2-step allotter is required the code point is cross-connected to an RCL- punching, either directly or through class screening relays. The RL- punching is cross-connected to route series relays, either directly or through class screening relays. The RCL- and RL- punchings are associated with the windings of the allotter relays AL- (FS-40, SD-26002). Therefore, the grounded code point will operate an AL- (allotter) relay. The operated AL- relay will close a ground under control of the AGP (allotter group preference) relay to the contacts of the GZ (group Z) relay. Associated with the break contacts of the GZ are LA- punchings and the make contacts are LB- punchings (FS-55, SD-26002). The LA- punching is cross-connected to an RC- punching associated with the R- (route) relay for one subgroup of trunks and the LB- punching is cross-connected to an RC- punching associated with the R- (route) relay for another subgroup of trunks. Since the GZ relay is operated on every other seizure of the marker, traffic is equally distributed to the intraoffice trunk circuits. The remainder of the test is the same as described in Paragraph 8.03.

Trunk Link Frame Preference

8.08 Since it is undesirable for the same trunk link frame to be first choice for the same marker on each usage, a rotating preference system is used. On the previous marker usage, one of the FMO-4 (frame memory) and FMG- (frame memory group) relays that correspond to the trunk link frame used were operated and held until this marker usage. If none were operated, such as after initial application of power, the FMO and FMGO would operate when power was applied (FS-21, SD-26002). The FMO operates through a chain of break contacts on the other FM- relays and released TFK1 relay. The FMGO operates through a chain of break contacts on the other FMG- relays and released TFK1 relay.

8.09 On this usage, the operated TLCL relay together with the held FM- and FMG- relays operate the FMK (frame memory check) relay, this in turn will operate the FMG (frame memory guard) relay. The operation of these two check relays is an indication that an FM- and an FMG- relay is operated.

8.10 The marker will be provided with an FS- (frame selection) relay per trunk link frame. There will be ten FS- relays if the office contains ten or less trunk link frames or twenty FS- relays if the office contains ten or more trunk link frames (OS 702-1) (FS-22, SD-26002).

8.11 The operating ground for the FS- relay is supplied through the operated FTC- relay corresponding to a trunk link frame with an idle intraoffice trunk and the contacts of the operated FM- and FMG- relays associated with the previous trunk link frame usage. If relay FTC- is released, indicating no idle intraoffice trunks, the ground is passed to the second higher numbered FTC- relay. If relay FTC- is operated, indicating idle intraoffice trunks, but relay FB- (frame busy) is operated, indicating a busy frame, the ground is still passed to the second higher numbered FTC- relay. If the FTC- relay is operated and the FB- relay that corresponds to the same trunk link frame is released, the ground is then applied to the FS- relay winding operating it (OS 702-2) (FS-22, SD-26002).

Trunk Link Frame Seizure (FS-1, SD-26033) (FS-2-3-4, SD-26039) (OS 702-2)

8.12 Each trunk link frame has a connector circuit and a preference control and make-busy circuit associated with it.

8.13 The trunk link connector consists of a set of multicontact relays for each marker. These relays provide the necessary leads between the markers and the trunk link frames. One set of multicontact relays operate at a time under control of the frame preference control and make-busy circuit. It also provides the marker with office size and frame arrangement information.

8.14 The preference circuit consists essentially of two chains of relays, one relay in each chain for each marker, and a transfer circuit to make operative one chain or the other. The transfer is brought into play either automatically in case of certain troubles, or manually when this is desired for maintenance purposes. The preference relays operate the multicontact relays in the trunk link connector circuit.

8.15 The control circuit permits only one marker to have access to a particular trunk link connector at a time.

8.16 In each preference control circuit there is one MP- (marker preference, regular) relay per marker in one chain and one E- (marker preference, emergency) relay per marker in another chain. The operation of the FS- relay in the marker connects resistance battery to the start lead "ST" to operate the MP- relay with the TR normal. The MP- relay locks to ground on its own contacts.

8.17 Assuming that an intermediate marker has operated its MP- relay, lower numbered marker MP- relays cannot operate since these are cut off by the contacts of the operated MP relay, but higher numbered markers can operate their MP relays. These relay winding chains and work contact chains prevent more than one marker from seizing the same trunk link connector at a time. When the connected marker releases its MP relay and MP relays for higher numbered markers are operated, the next higher marker will be served.

8.18 The operation of the MP- relay grounds the MC lead to the trunk link connector and causes the operation of the M relay under control of a chain circuit through normal MP- relays in lower preference circuits unless it is the lowest preference circuit. Relay M operates the MA1, MA2, MB1, MB2,

MC1 and MC2 relays. The TFK1 and TFK2 (trunk frame check) relays operate in the marker (FS-24, SD-26002) to indicate the seizure of the trunk link frame.

Recycle of Frame Memory Preference (OS 702-2) (FS-21, 23, SD-26002)

8.19 After the trunk link frame has been seized it will be necessary for the marker to reset the frame memory relays. The operation of relay TFK1 removes the locking ground from relays FM- and FMG- held from the previous usage, thereby allowing them to release. The release of relays FM- and FMG- releases relay FMK which releases relay FMG. The release of relay FMG, together with the operated relay FS- on this usage, operates the FM- relay that corresponds to the trunk link frame being used. Relay FMK reoperates. Because relay TFK1 is operated, relay FML (frame memory lock) operates and relay FMG remains nonoperated. The operation of relay FML releases relays BC0 and BC10, opening the trunk link frame FB- leads and releasing the operated FB- relays.

9. Number Group Selection, Seizure and Translation

Number Group Selection

9.01 When the marker receives the called number, it determines the called line location and the type of ringing required. The number group circuit is used to obtain this information. It translates the numerical digits of a subscriber line into equipment location on a line link frame. The marker determines the TH-, H-, T-, and U- digits of the called line number, selects the proper number group, which in turn translates the number into a line link frame number FT-, FU-, and location on the frame in terms of VG-, HG-, and VF-. The number group also provides the marker with the ringing code that the trunk should use in ringing the called line.

9.02 One number group circuit is assigned to each series of 1000 directory numbers in an office. Thus, a 10,000 number office has ten number group frames. The first frame serves 0000 to 0999, the second, numbers 1000 to 1999, up to the last frame for numbers 9000 to 9999. The marker examines the thousands digit of the called number to determine the particular number group circuit required.

9.03 Any given office may have from 1 to 40 number groups, each being capable of translating 1000 numbers. In order for the marker to select the proper number group, the thousands digit, TH0-9, plus an operated number series, NSS0-5, relay closes battery to one of the sixty punchings ST0-9 associated with the NSS0-5 relays. This punching is cross-connected to one of the ST00-39 punchings associated with the "ST" start lead for the number group connector. This causes the number group to be connected through the number group connector to the marker (FS-83, SD-26002) (OS 721-1).

Number Series Selection

9.04 A "number series" can be defined as a block of 10,000 numbers, 0000 to 9999 and one marker group is capable of handling four number series or a maximum of 40,000 numbers.

9.05 The markers are arranged to handle as many as six office codes, or office divisions. An office division, or code, may use the full 10,000 numbers of a number series. If an office division does not use a full 10,000 numbers, then two or three office codes can use the same number series division providing the hundreds digit within a number group does not conflict, and the office codes are served by the same "A" or "B" number group division.

9.06 The number groups are divided into "A" and "B" subdivisions with physical, theoretical and extra theoretical divisions in each of the "A" and "B" groups. Corresponding indications from the number group translation on PN, TN, or EN leads indicates the office division of the called number. The information is matched against the office division information the marker used in selecting the number group to operate the check relay.

Operation of Number Series Relay

9.07 The number series relay windings are associated with NSS- punchings and the office code group punchings are cross-connected to these punchings to operate the proper number series relay (FS-81, SD-26002).

Number Group Seizure

9.08 Each number group circuit has a preference control and make-busy circuit and a number group connector circuit associated with it.

9.09 The preference circuit consists of two chains of relays, one relay in each chain for each marker, and a transfer circuit to make operative one chain or the other. The transfer is brought into play either automatically in case of certain troubles or manually when it is desired for maintenance purposes. The preference control is used by the marker to gain access to the number group and its purpose is to permit only one marker to have access to a particular number group at a time. The preference relays operate the multi-contact relays in the number group connector circuit.

9.10 The control circuit permits only one marker to have access to a particular number group connector at a time.

9.11 The number group connector is a circuit which connects the marker to the number group circuit. The connector consists of a set of five wire spring multicontact relays designated MCA to MCE for each marker circuit. These relays provide the necessary leads between the marker and the number group circuit. Only one set of these relays associated with one marker are operated at one time under control of the preference control circuit.

9.12 In each preference control circuit there is one MP- (regular marker preference) relay per marker in one chain and one E- (emergency marker preference) relay per marker in another chain. These relays are under control of the battery closure to the ST- lead from the associated marker.

9.13 Assuming that an intermediate marker has operated its MP- relay, lower numbered marker MP relays cannot operate since these are cut off by the contacts of the operated MP relay but higher numbered markers can operate their MP relays. These relay winding chains and work contact chains prevent more than one marker from seizing the same number group connector at a time. When the connected marker releases its MP relay and MP relays for higher numbered markers are operated, the next higher numbered marker will be served.

- 9.14 After the marker seizes a trunk link frame, it seizes the number group. In order to do this, the following six conditions must be established:

<u>Condition</u>	<u>Checked by Relays</u>
Trunk link frame control relays operated in marker	TLCL and 2, operated (FS-33)
Marker has seized trunk link frame for intraoffice call	TFKL and 2 operated (FS-24)
Grounds for marker to set up terminating stage provided	FLG operated (FS-33)
Battery for number group provided	SNGL and 2 operated (FS-85)
Marker steered into proper number group	LPA, LTA, LEA, LPB, LTB, LEB, and associated NSS- (FS-40, 81)
Relays RIA, TBIA & BNA have not operated falsely	SP normal (FS-37, 89)

9.15 The operation of the LPA, LTA, LEA, LPB, LTB or LEB relay operates an NSS- relay (OS 721-1) (FS-81, SD-26002). Two out of the five operated THO, 1, 2, 4, and 7 relays determine which number group is to be seized. Contacts of these relays extend battery with the aid of the NSS- relay to an STO-9 (start) lead which is cross-connected to one of the number group ST00-39 (start) leads to operate the MP (marker preference) relay in the preference control circuit (OS 721-1).

9.16 The operation of the MP- relay grounds the MC lead to the number group connector and causes the operation of the MCA relay under control of a chain circuit through normal MP- relays in lower preference circuits unless it is the lowest preference circuit. This operates the MCB, MCC, MCD and MCE relays in the connector which closes through the leads necessary for completion of the call between the marker and the number group. The NGK and NGKL (number group check) relays operate in the marker to indicate the seizure of the number group (FS-1, SD-26035) (FS-85, SD-26002) (OS 721-1).

Number Group Translation

9.17 Each directory number of the 1000 numbers in a number group has three punchings (L, G, and F) assigned to it. One of each of these punchings is located in the three cross-connecting fields. A typical cross-connection

arrangement of the translator fields is shown in Fig. 4. The bottom field serves to identify the line link frame number and is called the LL field. The middle or RF field identifies the ringing combinations and vertical file. The top or VHG field identifies the vertical and horizontal groups.

9.18 In order to simplify the description of locating a called line, let us assume that the number ME 3-2909 was dialed. The office code registration and the number group selection by the thousands digit is described in previous paragraphs. Therefore, we are only concerned at this time with the last three digits (909).

9.19 Since the hundreds digit is 9, the tens digit is 0, and the units digit is 9, relays HN2 and HN7, T4 and T7, and U2 and U7 in the marker are operated. The operation of these relays connects 48-volt battery to the following number group leads (OS 722-1).

- (a) The HB9 lead to operate relay HB9 (hundreds block).
- (b) The TBO lead under control of the PN (physical number), PTN (physical and/or theoretical number), TN (theoretical number), or EN (exterior number) relay to operate relay TB90 (tens block) (FS-92, SD-26002).
- (c) The U9 lead under control of relay UC (units cut-in) to operate relay U9 (units).

9.20 The operation of an HB- and a U- relay causes the following relays to operate (OS 722-1):

- (a) The HB- relay operates relay PN, PTN, TN, or EN.
- (b) The HB- relay also operates relay TBW (tens block wetting) in series with a TB- relay.
- (c) The U- relay operates relay UK (units check). When relays UK and TBW operate, relay HTUK (hundreds, tens, units check) operates, allowing the call to be completed in the normal manner.

9.21 When relay NGK1 in the marker operates and relays HB9, TB90, and U9 in the number group operate, 48-volt battery is connected to the directory number punchings L909, G909, and F909. The battery path is over the WL, WG, and WF leads (FS-96, SD-26002). The L, G, and F punchings associated with each directory number are cross-connected to LL, VHG, and RF punchings in the translator fields, in accordance with the locations of the line hold magnet on the line link frame. In the assumption under discussion, these three punchings are cross-connected to the translator field punchings in the following manner, L909 to LL39, G909 to VHG11-9, and F909 to RF15-4. From this information, it is seen that the directory number ME 3-2909 is located on line link frame 39, in vertical group 11, in horizontal group 9, in vertical file 4, and that it uses ringing combination 15.

9.22 The frame number is indicated to the marker over two sets of leads.

A set of four FT leads indicates the tens digit of the frame number, and a set of ten FU leads indicates the units digit. Thus, for the line link frame number, it is necessary to convey two pieces of information. From

this it may seem that two cross connections are required, one for each piece of data. By the use of a resistor network, however, it is possible to provide these two pieces of data with only one jumper connection.

9.23 Each of the line link frame number terminations to which the directory numbers are cross-connected is associated with the frame tens and units leads to the marker through a pair of resistors. Thus, when battery is applied to punching LL39, a current flows through the FT resistor to the FT3 lead into the marker, where it is recognized as a frame in the thirties; current also flows through the FU resistor to the FU9 lead into the marker, where it is recognized as a frame with a 9 units digit. The resistor networks are described more fully later under Called Line Information Transfer to the Marker.

9.24 A similar arrangement is used for combining the vertical and horizontal group information and also for combining the vertical file and ringing combination information.

9.25 As stated before, the directory numbers in some offices are divided into groups. All of the numbers within the same hundreds block can be assigned to only one of the groups. It may be desirable to provide some of the directory numbers with nonrestricted service; these numbers are known as nondiscriminating numbers. When the numbers in an office are not divided into groups, all numbers are assumed to be physical, and relays TN, EN, and PTN are not provided.

9.26 Each HB- relay in the number group has a contact wired to a PT (physical-theoretical) punching. This punching is cross-connected to a PN, PNL, TN, TNL, EN, ENL, PTN, or PTNL punching (FS-14, SD-26034). When one of these punchings is grounded by the operation of the HB- relay, the associated relay operates, provided that the physical, theoretical, or extheo indication received from the office code dialed agrees with the physical, theoretical, or extheo indication received from the number group. If the indications agree, the call is completed; if they do not agree, the call is routed to a no-such-number tone trunk or to an operator.

9.27 Under certain conditions, parts of two different thousands series of numbers are placed in one number group. For example, official and coin lines are usually placed in the 9000 series. In offices having less than 9000 numbers, these lines will have to be placed in another number group. When the number group serves a single thousands series of numbers, the PT terminal is cross-connected to the PN, TN, EN, or PTN punching, depending on whether the hundreds block contains physical, theoretical, extheo, or nondiscriminating numbers. When the number group serves two different thousands series of numbers, the numbers in the original series of the partly used thousands series are cross-connected as above. In the added thousands series, the PT punching is cross-connected to the PNL, TNL, ENL, or PTNL punching.

9.28 Ground on a PN, TN, EN, or PTN punching in the number group operates a similarly designated relay in the marker. Ground on a PNL, TNL, ENL, or PTNL punching operates the corresponding PN, TN, EN, or PTN relay, provided that relay AST (A series start) is operated.

9.29 If the office code dialed is a local physical number in Office A, relay LPA is operated. If the dialed numerals also represent a physical number, the number group indicates this fact to the marker by operating relay PN. Since

the office code and the numerals match, the ground from a contact of relay LPA through a contact of relay PN operates the PTK (physical and theoretical check) relay. This permits the call to proceed.

9.30 If, through error or in order to avoid paying an extra charge, the office code dialed is a local physical number in Office A and the numerals dialed represent a theoretical number in the same office, a blank number is indicated. The office code dialed causes the operation of relay LPA. Since the numerals dialed represent a number assigned for theoretical numbers, relay HB- operates relay TN. Relays LPA and TN together operate the BN (blank number) relay. Now the call is routed to a no-such-number tone trunk or to an operator. This same matching operation also applies to relays LPB, LTA, LTB, LEA, and LEB.

9.31 If the office code dialed is a local physical number in Office A, relay LPA is operated. If the dialed numerals also represent a physical number in an added thousands series, relay AST is operated (FS-61, SD-26002). The number group grounds the PNL punching and operates relay PN in the marker. Since the office code and numerals match, the marker operates relay PTK and permits the call to proceed. If relay AST were not operated, the ground on punching PNL operates relay BNTH to route the call to a no-such-number tone trunk or to an operator.

9.32 If the called line is connected as a nondiscriminating number in the number group, the call is completed regardless of whether the physical or theoretical office code is dialed. For this condition, relay PTN is operated and ground is connected directly to relay PTK, which permits the call to proceed.

9.33 Different treatment of directory numbers can be given by the omission of one or more of the cross connections between the L, G, and F and the LL, VH, and RF punchings. Numbers can also be blanked out by cross-connecting the PT punching to the BNK punching (FS-11, SD-26034). In this manner, groups of 100 to 1000 numbers can be omitted. Blank, permanently busy, intercepted, and free numbers are treated in this manner.

9.34 There is another function that the number group performs for the marker, that is, indicating when terminal hunting is required. Some of the lines of any number group may be PBX trunks. For those lines, cross connections for PBX and terminal hunting groups are made in the marker in order to gain access to the sleeve leads that are required for terminal hunting.

10. Called Line Information Transferred to the Marker

10.01 When 48-volt battery is connected to the L909, G909, and F909 punchings as previously described, the following relays in the marker operate (OS 722-1):

- FUN9 (frame units number 9)
- FTN3 (frame tens number 3)
- HGN9 (horizontal group number 9)
- VGN11 (vertical group number 11)
- VFN4 (vertical file number 4)
- RCN15 (ringing combination number 15)

These relays are connected through the resistor networks to the translator fields. Although there is a multiplicity of parallel paths in these translator fields, the current through any relay can be calculated from the information shown in Fig. 5. About nine-tenths of the current flows through the relays, which should operate, and about one-tenth of the current flows through each of the remaining relays in parallel, which should not operate. The FUN-, FTM-, HGN-, VGN-, RCN-, and VFN- relays have a high nonoperate adjustment. They are sensitive enough to permit two of them to operate in parallel if a cross develops between two of the information leads to the marker. This is necessary in order to give a trouble indication and to prevent the selection of a wrong number.

11. Trunk Selection

Trunk Blocks and Trunk Groups

11.01 The trunks connect to horizontals or levels on trunk switches on the trunk link frame. There are two trunk appearances per level for levels 2 to 9 on the 10 trunk switches. The two appearances per level are obtained by using a 6-wire switch and operating a T0 or T1 select magnet (Position 0 or 1 respectively) in addition to the T select magnet associated with the level on which the trunk appears. The T0 or T1 select magnet controls crosspoints which connect the link to one or the other of two vertical multiples each consisting of a tip ring and sleeve (OS 709-1). The trunk select magnet T controls crosspoints which connect two horizontal tip, ring and sleeve multiples (corresponding to two trunk appearances) to the two vertical multiples, but, as was just explained, only one vertical multiple is connected to a link. In this manner we have effectively obtained 16 trunk appearances per switch or 160 trunk appearances per frame. The trunks that have their connection to the marker predetermined are assigned to 40 of these appearances. For example, an incoming trunk from another office, when used on a call, is identified to the marker, and the marker must connect to this particular trunk to assist the call. The remaining appearances (120) are assigned to originating registers and those trunks which the marker may select. For example, the marker may use any idle intraoffice trunk of the proper type or any idle outgoing trunk of the proper type (AMA, flat rate, coin, etc.) that connects to the desired completing office.

11.02 Appearances connected by a T0 select magnet are called A appearances and those by a T1 select magnet, B appearances.

11.03 Associated with each A appearance is an FA relay and with each B appearance an FB relay. These relays are effectively trunk connector relays and are operated by the F relay in the trunk. Intraoffice trunks require two appearances on the same trunk link frame and on the same level but on different switches. The calling end is on an A appearance and the called end is on a B appearance. The B appearance is on a switch one higher in number than the one containing the A appearance. Incoming trunks and other trunks requiring ringing are on B appearances. Registers, outgoing trunks and other trunks handling outgoing calls may be on either A or B appearances.

11.04 Trunks requiring ringing have a hold magnet on a ringing selection switch. The proper ringing combination is set by operating select magnets on this switch.

11.05 Access to these magnets is obtained through the trunk link frame connector and level connector relays. The 10 verticals of a ringing switch are associated with one level on the 10-trunk switches of one trunk link frame.

11.06 The 120 appearances or outlets are assigned to trunk blocks (TBO-5) which consist of twenty trunks and/or registers each. In addition to the originating registers, one or more types of trunks may be assigned to this same trunk block. In order to differentiate these from each other, and from registers, a further subdivision of twenty test groups (TGO-19) is provided. Originating registers and each trunk of a group, within one trunk block, are assigned to different test groups, therefore, a particular route may be considered as identified by the combination of TB number (corresponding to TB relay number) and TG number (corresponding to TG lead number) associated with it.

11.07 In the trunk link circuit there is an F punching associated with the F lead of each trunk and a TG punching associated with the TG lead from the marker. All of the F punchings associated with the same trunk group are connected to the same TG punching (OS 718-1) (FS-1, SD-26032).

11.08 The F relays for intraoffice trunks are connected to the TB4 or TB5 relays and are always associated with levels 6, 7, 8 or 9.

BT Leads

11.09 In the trunk each F lead is connected through an F relay winding, through contacts, which are open while the circuit is busy, and then to a BT punching. These BT punchings are connected to contacts of the TB relay associated with the level on which the trunks appear. The BT punchings of intraoffice trunks are always connected to the TB4 or TB5 relay (OS 718-1).

11.10 Although an intraoffice trunk has both an A and a B appearance, the selection of the trunk is determined by the condition on the BT lead associated with the A appearance.

Testing and Seizure of Idle Intraoffice Trunk

11.11 Before selecting the trunk link frame the marker has determined that one or more intraoffice trunks are available for use.

11.12 Following seizure of the trunk link frame, the marker determines which intraoffice trunks are idle, and then selects one that is idle.

11.13 Battery from the marker operates the TB4 or TB5 relay in the trunk link circuit when the connector cut-through relays operate. The operation of the TB- relay is checked by relay TBK (trunk block check) in the marker (FS-27, SD-26002).

11.14 When the TLCl relay operated in the marker it permitted the marker to determine that none of the TSO-9 (trunk select) relays were operated by the operation of the TSEL-2 (trunk select end) relays. This check insures that the marker will first test for and then select an idle trunk. The operated TSEL-2 relays provide battery for testing and selecting an idle trunk.

Test for an Idle Trunk (OS 718-1) (FS-27, SD-26002)

11.15 When the TB4 or TB5 relay has operated the BT leads are extended to the marker to permit testing for an idle intraoffice trunk. Ground is extended from the marker TGP or TGS relay (controlled by an even or odd numbered TG relay) through the TG- relay to the TG- punching in the trunk link circuit. This punching is cross-connected to the F punchings associated with all the intraoffice trunks on the selected trunk link frame. Idle trunks will extend ground back into the marker over the "BT00-19" leads to operate the associated TTO-9 (trunk test) relays.

11.16 The TTO-9 relays are double wound with each of the windings being associated with one of the "BT" leads. An idle trunk is indicated by the operation of a TT relay.

11.17 Due to the use of the double wound TT relays it should be understood that the operation of a TT relay does not alone indicate the particular trunk that is idle. The marker must determine which one of the two "BT-" leads is grounded with an odd and even preference scheme.

Trunk Selection (FS-28, SD-26002)

11.18 When the TSE1, TBK, and MAK1 relays have operated, ground is extended through the operated or unoperated SQO (sequence) relay through an operated JSQO-5 (junctor sequence) relay to the TTO-9 relay operated to operate a TS (trunk select) relay. The operated TS relay locks under control of the TLC1 relay, releases the TSE1-2 relays which in turn release the TTO-9 relays.

11.19 The JSQO-5 relay circuit tends to distribute the traffic handled by the marker among the trunks.

11.20 With the operation of the TS relay, marker selection of a trunk is directed to one of the two trunks that may be associated with these two "BT-" leads which appear on a particular TT relay. These leads which indicate idle trunk circuits when grounded are extended to an OTS (odd trunk selection) and an ETS (even trunk selection) relay to permit selection of one of the two leads. If at this time only one of the two leads is grounded the operated or unoperated condition of the TZ (trunk sequence) relay has no significance. Therefore, if the odd BT- lead is grounded the OTS relay operates, and if the even BT- lead is grounded the ETS relay operates. If however the BT- leads are both grounded, then the operated or unoperated condition of the TZ will determine the selection of either the OTS relay or the ETS relay.

Preference Lockout Circuit (OS 718-1) (FS-27, SD-26002)

11.21 The ETS and OTS are double winding relays in which the current through the primary 10-ohm winding is in a direction to operate the relay, and the current through the secondary 200-ohm winding tends to nonoperate the relay. When both windings are energized the current through the 200 ohm or biasing winding is of sufficient magnitude to hold the relay released. If the TZ relay is nonoperated the bias winding of the ETS is opened. Therefore, with ground on both the odd and even BT- leads the ETS relay would operate and the OTS relay would be biased to nonoperate.

- 11.22 However, if the TZ relay was operated, the OTS biasing winding is opened and the OTS relay would be preferred.
- 11.23 Operation of either an OTS or ETS relay opens the operating circuit of the other relay.
- 11.24 For trouble recording purposes an OT (odd trunk) relay would operate on odd trunk selection. The operated or unoperated condition of the OT relay and the selected trunk TS- relay will give an indication of which trunk was selected.
- 11.25 The busy tests were made with high resistance marker relays which would not operate the 16-ohm frame cut-through relay of the trunk.
- 11.26 The operation of the OTS or ETS relay changes the high resistance to low resistance which locks the OTS or ETS operated and operates the frame F- cut-through relay of the trunk.

12. Release of the Number Group

12.01 The number group translates the numerical registration of the directory number and transfers it to the marker. This operates one of each of the FUN-, FTN-, HGN, VGN-, VFN-, and RCN- marker relays (OS 722-1). These relays operate their corresponding test relays FUT- (frame units test), FTT- (frame tens test), HGT- (horizontal group test), VGT- (vertical group test), VFT- (vertical file test), and RCT- (ringing combination test) (OS 724-1). Each of the test relays operates one of the locking relays FUL, FTL, HGL, VGL, VFL and RCL which lock under control of relay LLI (line lock identification). This relay later releases the test relays so that they can be used in the originating stage of this call.

12.02 After the called line location is recorded in the marker, the number group is released. This is done when the line identification locking relays in the marker cause the operation of the RNG (release number group) relay (OS 724-1). Relay RNG operates relay NR (number release), which releases relay NSS- and relay N- (FS-81, SD-26002). The operation of relay RNG also releases relays SNG1 and SNG2 (OS 721-1). Relay SNG2 releases the MP- relay in the preference control circuit, thereby releasing the number group connector and number group circuit.

13. Selecting the Line Link Frame - Call-Forward Linkage

13.01 After the location of the called line is identified, the marker connects to the line link frame and tests the called line for a busy condition. If the called line is idle, the marker assists in the connection from the selected intraoffice trunk to the called line. The called line information received from the number group is used to direct the marker to seize the line link frame that contains the called line.

13.02 Each line link frame has a preference control and make-busy circuit and a line link connector circuit associated with it.

- 13.03 The preference circuit consists of two chains of relays, one relay in each chain for each marker, and a transfer circuit to make operative one chain or the other. The transfer is brought into play either automatically in case of certain troubles or manually when it is desired for maintenance purposes. The preference control is used by the marker to gain access to the line link frame and its purpose is to permit only one marker to have access to a particular line link frame at a time. The preference relays operate the multicontact relays in the line link connector circuit.
- 13.04 The control circuit permits only one marker to have access to a particular line link connector at a time.
- 13.05 The line link connector is a circuit which connects the marker to the line link frame. The connector consists of four wire spring multicontact relays designated MA1, MA2, MB1 and MB2 for each marker. These relays provide the necessary leads between the marker and the line link frame. Only one set of these relays associated with one marker are operated at one time under control of the preference control circuit.
- 13.06 In each preference control circuit there is one MP- (regular marker preference) relay per marker in one chain and one E- (emergency marker preference) relay per marker in another chain. These relays are under control of the battery closure to the ST- lead from the associated marker.
- 13.07 Assuming an intermediate marker has operated its MP- relay, lower numbered marker MP- relays cannot operate since these are cut off by the contacts of the operated MP- relay, but higher numbered markers can operate their MP- relays. These relay winding chains and work contact chains prevent more than one marker from seizing the same line link connector at a time. When the connected marker releases its MP- relay and MP relays for higher numbered markers are operated, the next higher marker will be served.
- 13.08 Previously, it was assumed that the called line is located on line link frame 39. Therefore, with relays PTK, RCL (ringing control lock), FTT3, and FUT9 operated, 48-volt battery is connected to the ST-39 (start) lead (FS-5, SD-26002). This lead is wired to the preference control circuit associated with the line link connector for line link frame 39 to operate the MP- relay associated with the marker.
- 13.09 The operation of the MP- relay grounds the MC lead to the line link connector and causes the operation of the MA1 relay under control of a chain circuit through normal MP- relays in lower preference circuits unless it is the lowest preference circuit. This causes the operation of the MA2, MB1 and MB2 relays in the connector which closes through the leads necessary for completion of the call between the marker and the line link frame. The LFK (line frame check) relay operates in the marker to indicate the seizure of the line link frame (FS-1, SD-26031) (FS-5, SD-26002).

14. Operation of the Called Line Identification Relays

- 14.01 The operation of the HGT- relay in the marker operates an HGA- and HGB- (horizontal group) relay in the line link and marker connector control circuit (FS-2, SD-26030). These horizontal group relays cause the operation of the HGK (horizontal group check) relay in the marker.

14.02 The operation of the VGT- relay in the marker operates a VGB- (vertical group auxiliary) relay in the line link and marker connector control circuit (FS-2, SD-26030). The VGB- relay operates from direct ground if the marker group is arranged for a maximum of 30 classes of service, or from ground in series with a CGA or CGB relay in the marker, if the marker group is arranged for 60 classes of service.

14.03 With the HGA-, HGB- and VGB- relays operated a path is closed from the line group relay LG- to the "BS" lead. However, the "BS" lead does not have battery connected to it by the marker until the marker HGK relay has operated (OS 705-1). After the HGK relay operates then the LG- relay in the line link and marker connector control circuit operates (OS 705-1).

14.04 With the LG- relay and the VFT- relay in the marker circuit operated a partial path is closed to the L- hold magnet. The completion of this path is described under Select and Hold Magnet operation.

14.05 The operation of relays FTK1, HTK1, and VTK1 in the marker checks that only one of each of the VFT-, HGT-, and VGT- relays, respectively is operated (FS-6, 7, 8, SD-26002).

14.06 The foregoing description shows how the hold magnet associated with the directory number ME 3-2909 is found to be in vertical file 4, horizontal group 9, and vertical group 11 of line link frame 39.

15. Selection and Application of the Ringing Combinations

15.01 In providing telephone service, it is often necessary to connect more than one customer to a single line (party lines). This makes it necessary to supply different types of ringing codes in order to identify the party called. A party who has full selective ringing hears ringing only when his station is being called. A party who has semiselective ringing hears ringing for his own and one other station. On individual, 2-party, and 4-party full selective lines, therefore, each party hears only his own ringing, while on 4-party and 8-party semiselective lines, he hears also the ringing for one other party. However, on 10-party lines, he hears the ringing for four others.

15.02 On party lines, one half of the stations are arranged to be rung over the ring conductor and one half over the tip conductor. Ringing current is 20-cycle current superimposed on a negative dc component to permit the tripping relay to operate when the party answers. However, on 8-party semiselective lines and 4-party full selective lines, a further limitation in the ringing a party hears is made possible by superimposing the interrupted 20-cycle ringing current on either negative or positive direct current. To specify a ringing code completely, it is therefore necessary to state the side of the line to which ringing is applied, whether it is negative or positive superimposed, and the particular code to be used. These various ringing selections and ringing combinations are shown in the tables on (OS 725-1).

15.03 Crossbar switches are used to apply ringing current to the trunks. One 10-vertical crossbar switch is used for each ten trunks per trunk link frame, per level, which requires ringing. Each trunk circuit is connected to a switch vertical through which any one of the required types of ringing is selected.

15.04 The number group selects the ringing combination for a particular line and passes it to the marker. This was previously described with the assumption that the RCM15 relay operated. The marker sets up the ringing condition on the selection switch and then transfers the control of the ringing to the intraoffice trunk.

15.05 Levels 0 and 1 on the crossbar switch are used to apply ringing to either the tip or ring conductors of the line and ground to the other conductor. Levels 2 to 8 select the types of ringing supplied by the ringing power plant. Level 9 is used to indicate busy and overflow conditions. Each ringing selection requires that two out of ten of the select magnets are operated.

15.06 When an RCT- relay in the marker operates to select the ringing combination, it operates two of the RS- (ringing select magnet)-relays (OS 725-1). Each of these relays operates one of the select magnets on the ringing selection switch through the previously operated LV- (level connector) relays. Battery is connected either to the SMO or SMI select magnets to determine whether the ringing is to be placed on the tip or ring of the trunk. Similarly, battery is also connected to one of the RS2 to RS8 leads to operate one of the select magnets that determines the ringing code.

15.07 As a check that one of the ringing selection switch select magnets has operated, relay RSK (ringing switch select magnet check) in the marker is operated (OS 725-1). Only one operated select magnet is necessary to operate relay RSK. The operation of relay RSO or RSI and the associated select magnet, or the operation of one of the relays RS2 through RS9 and the associated select magnet, is delayed until after the operation of relay RSK.

15.08 The operation of relay RSK operates relay SRK (start ringing check), which in turn operates relay LI (line idle). When relay LI operates, it extends resistance ground from the marker to the selected intraoffice trunk to operate its RC (ringing control) relay.

15.09 Relay RCK1 (ringing switch check) checks the closure of the ringing selection switch crosspoints (OS 725-1). When relay CKG6 operates at the beginning of the call, 210-ohm battery is connected to the negative punching of the primary winding of relay RCK1. Relay LI connects 20-ohm ground to the same terminal. This causes the negative terminal to be positive with respect to the 48-volt battery voltage. The positive terminal of the primary winding is connected to 48-volt battery through the RC relay winding. Since the positive terminal is thereby placed at a lower voltage than the negative terminal, the current through the primary winding prevents the operation of relay RCK1. When the ringing selection switch crosspoints are closed, a holding ground is supplied over the G lead to relay RC in the trunk via the RA lead. This holding ground on relay RC is extended over the RC lead to the positive terminal of the primary winding of relay RCK1. The resulting current is in the proper direction to operate the relay. Therefore, relay RCK1 operates as a check that the ringing selection switch crosspoints have closed. The closure of the ringing switch crosspoints also connects the selected ringing current and ground to the tip and ring of the trunk, in series with its RT (ringing trip) relay. Finally, ground on the G lead in the trunk circuit is connected through the crosspoints and returned on the RA lead. This ground holds the trunk in the ringing condition until ringing is tripped or until the call is abandoned.

15.10 With code 1 ringing, there is no possibility of the code being misinterpreted, since it consists of only one ring. If the first ring is shorter than the others, no confusion results. Therefore, the code ringing supply is connected at once without waiting for the end of the ringing cycle. The PU (pick-up) relay in the trunk is operated immediately from ground on the PKU lead. On calls that require other than code 1 ringing, relay PU is operated from the pick-up ground after relay F releases. This insures that ringing starts on the beginning of the ringing cycle, and thereby avoids the connection of a clipped ringing code to the trunk. Ringing of the called line, however, does not take place at this time because the T and R leads to the line are kept open by the operated FB-- (B appearance trunk) connector relay. These relays are under control of the F relay in the trunk. Relay F does not release until various channel, junctor, and double connection tests for both the originating and terminating connections are completed.

16. Class Information and Class Check

General

16.01 On some intraoffice calls, the marker operates relays to set a charge condition in the trunk, to identify tip or ring party or to identify class of service of calling subscriber. On some other intraoffice calls, the marker does not have to send class information to the trunk. Just what information the marker passes to the trunk and whether it need pass any class signals at all are determined by the type of intraoffice trunk circuit and the calling subscriber's class of service.

16.02 The route series relay determines what, if any, information is sent to the trunk. Therefore, when the marker cross connections are laid out, the route series relay is chosen so that it fills the requirements for class signal (information) to the trunk. While some of the route series relays have descriptive names (NCNC - noncharge, noncoin, etc.), these names should not be accepted as a criterion for their use. The route series relay is chosen because it causes the marker to ground certain class leads or not to ground any leads. Reference sheet RM 702-1 is a table which lists various trunk circuits, including intraoffice, gives the conditions under which the trunk requires or does not require class signals, and also shows the marker relays involved. The student will find this table helpful in understanding the selection of route series relays used on the route relay (OS 716-1).

16.03 Where the marker does send class information to a trunk, it operates a class ground supply relay (CLG) and operates a relay in the trunk and one of its own relays from the same ground. It operates a timer to give the trunk a chance to lock operated its class relay. The trunk returns ground to the marker on the same lead. This ground from the trunk holds the marker class relay operated after the marker cuts off the original ground supply (CLG) relay. Then the marker makes a check to see if its class relay is still operated.

16.04 When no class ground is sent to the trunk, the marker operates a no-class check (NOC) relay. On any originating call, a marker must operate either the class check (CLK) relay or no-class check (NOC) relay.

Flat Rate Call

16.05 Now let us take some practical examples of class check operation. On OS 716-1, Sheet 2, we have the route relay cross connections for intra-office routes. Three kinds of intraoffice trunks are represented: flat rate, message rate (AMA) and coin. First we shall discuss a flat rate subscriber in either PO-5 or PO-6 making an intraoffice call. The operated route relay is R10, the route series relay is NCNC. The table on RM 702-1, indicates that NCNC does not send class information grounds to the trunk (no-class leads grounded) since we have a flat rate customer calling a route which is a free call using a flat rate trunk. There is no need to "set" any of the conditions mentioned in the first paragraph. On SD-26002-01, FS-42, we should be able to operate the no-class check (NOC) relay. Here is its operating path; an underlined relay is normal.

NOC — CLT1, AMA, CLG, NSI, SON, (RP, TP) or (RP, TP), TC, CNC, NCNC, OPR, BL, VP, CAA.

The operated NCC relay satisfies the marker that no class was transmitted to the trunk.

Coin Charge Call

16.06 If we consider a coin subscriber in either PO-5 or PO-6 making an intraoffice call, the route relay is R20 and the route series relay is TCNC (talk charge, noncoin). This is one of the instances where the route series relay name does not fit the case since our subscriber is coin. The reason for this is that the intraoffice trunk represented by R20 is a coin intraoffice trunk (SD-26064-01, for instance). It has a TC lead but no CN lead. It is designed to handle only coin traffic; it does not require a coin signal. Route series relay TCNC provides a ground on the TC (talk charge) lead to the trunk.

16.07 On this call, we can't find a path for operating NOC relay on FS-42. However, later in the call when the RCK3 relay operated, it closed a path for operating the CLG (class ground supply) relay. On FS-43, CLG operates TC through contacts of TCNC.

TC — TCNC, FNB, FNA, VP, PBY, CAA, CLG.

This same ground goes through normal TOS and normal TER2 to the TC lead of the trunk operating the trunk TC relay. The trunk TC relay locks and returns ground on TC lead to hold operated the marker TC relay. On FS-42 the CLG operates the CLT (class ground timer) relay. The CLT operates CLT1 which releases the CLG. The marker and trunk TC relays remain locked to ground in the trunk if the transfer of class ground has been successful. The CLT1 operates CLT2 and this closes a path for the CLK (class check) relay.

CLK — CLT2, AMA, CLG, NSI, SON, RP, TP, TP, TPK, TC, FNB, FNA, CNC, TCNC, OPR, BL, VP, CAA.

The operation of the CLK satisfies the marker that class information has been successfully transferred to the trunk.

16.08 The process of class transfer and check for a message rate subscriber using a message register charge trunk is similar to the coin call just described. However, if the intraoffice message rate trunk is equipped for AMA operation, the process is different.

Message Rate Call

16.09 Suppose on OS 716-1, Sheet 2, a message rate class of service makes an intraoffice call. The operated route relay is R10 and the route series relay is MBS1 (message billing index No. one). On AMA charge calls, the marker does not send class information to the trunk. It does send tip or ring party identification to the outgoing sender. The sender, later on, passes this information to the AMA equipment. In order to check the transfer of the RP or TP to the sender, the marker goes through a class check process.

16.10 On AMA intraoffice calls, the marker selects an outsender. The sender does no pulsing, but is required for passing information from the crossbar equipment to the AMA equipment. The marker functions for selecting a sender on intraoffice AMA calls are the same as for outgoing calls. The details of this process are explained in Section 6. Those relays which would have been operated, by the time the marker makes class check, will be assumed to have been operated.

The marker operates the CLG relay on intraoffice AMA calls. Path of CLG starts on FS-42:

CLG — AMA4, RK3 (to FS-77) TGS2, AMA3, TGS1, ORK2, ORK1, KK (to OSC)
MA, MB, SB, SA, SC, MC.

On FS-43, the operated CLG provides a ground for operating RPK (ring party check) if RP relay is operated, or TPK (tip party check) if TP relay is operated. Either RP or TP was operated when the originating register passed the calling subscriber's line location to the marker. The same ground operates either RP or TP in the sender, the sender RP or TP relay returns ground to hold operated the marker check relay RPK or TPK. The CLG operates the OST1 (out sender timer) on FS-77. OST1 operates OST which in turn operates OST2. A detailed explanation of the OST relay operation is in CD-26002-01. The operated OST2 releases the TGS1 and TGS2 on FS-77. The TGS1 and TGS2 open the operating path of the CLG relay.

On FS-42 we can operate the CLK relay when the CLG releases. The path is:

CLK — AMA4, CLG, NDK, NSI, SON, (RP, TP) or (RP, TP), (TP, TPK),
(RP, RPK) or (TP, TPK), (RP, RPK) AMA, AMA4.

The operated CLK relay indicates to the marker that it has successfully transferred tip or ring party information to the sender. The marker checks the class check results when it operates the DCT2 relay. Either NOC or CLK must be operated to operate DCT2 relay.

17. Channel Test and Selection

General

17.01 The marker has seized a trunk link frame that has idle intraoffice trunks and is connected to one of these trunks. The marker is also connected to the line link frame that has the called line appearance. Now the marker proceeds with the selection of the connecting path from the trunk to the called line.

17.02 There are at least half as many trunk link frames as line link frames. Each line link frame terminates 100 junctors and each trunk link frame terminates 200 junctors. Depending on office size, there are ten to fifty junctors common to a line link frame and a trunk link frame. They are divided into subgroups, the first containing ten and the others ten or fewer junctors. For offices with more than twenty line link frames, extension trunk link frames are provided. They allow a pair of trunk link frames to share a group of junctors, thereby maintaining at least ten junctors available for connections to each line link frame.

17.03 In selecting a channel, the marker tests:

- (a) The ten line links on the line switch connecting to the called line.
- (b) A subgroup of junctors to the trunk link frame connecting to the intraoffice trunk.
- (c) The ten trunk links from these junctors to the trunk switch connecting to the intraoffice trunk.

By testing the ten channels formed by these elements, the marker selects an idle channel for the connection.

17.04 If no channel is found, the marker steps the junctor subgroup selection and again makes channel test. If this fails or if there is only one subgroup, another register is seized and channel selection is again attempted (marker recycle).

Junctor Distribution (FS-12, 13, 14, 17, SD-26002) (OS 707-1)

17.05 Office size determines junctor distribution. When junctor distribution is uniform for all frames, the operation of relay TLC1 (trunk link control) operates one of the 2TLF-1OTLF relays via the SZD to SZ- cross connection. Relay TLC1 also operates relay STF (single-trunk link frame) or relay PR (paired-trunk link frame) via the SPF to SF or SPF to PR cross connection. The 2TLF-1OTLF relay indicates how many trunk link frames or pairs of frames are in the office, therefore, the junctor distribution is indicated. The STF or PR relay indicates single frames or pairs of frames. In addition to these relays, auxiliary indication of office size is given by relays 20F (maximum of 20 line link frames), 40F (21 to 40 line link frames), 7Q (7 quad) for 7 trunk frames or pairs of frames, or RQ (regular quad) for 6, 8 or 9 trunk link frames or pairs.

17.06 During changes in office size, the trunk link frames are arranged for different junctor distribution. As the work progresses some trunk link frames will have junctor distributions corresponding to the new office size, some to an intermediate size, and some to the original size. For example, suppose that the 10 line link - 5 trunk link frame office is to be expanded to the 12 - 6 office. In the 5-trunk link frame size the junctor groups contain twenty juncctors, ten in each subgroup. The change in distribution resulting from the addition requires the removal of some of the juncctors from the second subgroup to form new junctor groups to the added line link frames. During this work the subgroup is unusable. To prevent the selection of this subgroup, the trunk link frame is temporarily arranged to indicate to the marker that it has the same junctor distribution as a trunk link frame in an office with ten trunk link frames, namely, only one subgroup of ten juncctors. After completion of work on this frame, it is then arranged to indicate its new distribution - for an office with six trunk link frames.

17.07 For an office being expanded from 5 to 6-10 trunk link frames, relay 10TLF is used as an intermediate office-size relay; for expansion from 3 to 4 or 5 frames, relay 5TLF is used; and for expansion from 2 to 3 frames, relay 2TLF-3TLF is used. It should be noted that the 2TLF-3TLF relay is used only as an intermediate office-size relay.

17.08 During transition, the 2TLF-10TLF relays are operated via cross connections SZA, SZB, and SZC to SZ- in the marker and G to SZA, SZB, and SZC in the individual trunk link frames; punching SZD is not used during this period. When the transition involves adding extension trunk link frames to pair the frames, the G to SF or G to PR cross connection in the trunk link frame permits the operation of relays STF or PR in the marker until the changeover is complete.

Junctor Subgroup Selection (OS 706-1, OS 707-1) (FS-12, 13, 15, 17, 46, SD-26002)

17.09 The junctor subgroup to be tested depends on the frames to be connected, the junctor distribution, and the junctor sequence circuit setting.

17.10 As stated in 17.02, the number of juncctors in a junctor group (particular trunk link to particular line link frame) may vary from a maximum of fifty juncctors to a minimum of ten juncctors. When the number of juncctors in a junctor group is in excess of ten, the junctor group is divided into subgroups. Since a subgroup may contain from one to ten juncctors, the number of junctor subgroups may vary from a maximum of five to a minimum of one.

17.11 The STP1 (stepping) relay and the JSQ0-5 (junctor sequence) relays control junctor subgroup selection for the first step. When more than one subgroup is provided, the second step in subgroup selection is controlled by the STP2 relay and the JSQ0-5 relays. The first selected subgroup always contains a full complement of ten juncctors. The second selected subgroup may contain from one to ten juncctors.

17.12 When the marker selects a subgroup which contains the full complement of ten juncctors, the PNR (pattern normal) relay is operated. However, when the selected junctor subgroup consists of less than a full group of ten

junctions one of the junctor pattern tens digit number PA, PB or PC relays and one of junctor pattern units digit PO-9 relays will be operated to identify the junctor subgroup pattern and to identify the junctions within the junctor subgroup which are available.

17.13 The number of junctions within a junctor subgroup will vary from a maximum of ten junctions to a minimum of one junctor depending upon the office size and the selected junctor subgroups. The marker is equipped to simultaneously test ten separate channels therefore the marker must determine those channels which are incomplete because of nonexistent associated junctions within the selected junctor subgroup. The marker must then consider these incomplete channels unavailable so that the marker will not select one of these incomplete channels for service.

17.14 As outlined in 17.03, the marker tests the line links, trunk links, and junctions to select an idle channel. The test leads for 20 junctions, which are associated with a particular horizontal level on the trunk link frame junctor switches, are under control of a junctor connector relay JC0-19. Of the twenty junctions, ten are connected to the left half and ten to the right half of the switches. The left half is controlled by relay L (left) and the right half by relay R (right). In single frame or paired frame offices the JC0-9 relays control horizontal levels 0 through 9 on the regular junctor switches. In paired frame offices, the JC10-19 relays control horizontal levels 0 through 9 on the extension junctor switches. When there are extension frames, relays EL (extension left) and ER (extension right) are also provided. The JCK relay operates in the marker as an indication that the JC- has operated on the trunk link frame (OS 707-1).

17.15 Each junctor in the subgroup has a J-test lead. By operating one JC-relay and either the L or R relay, the marker connects these leads to the CHT0-9 (channel test) relays. A busy junctor would cause the operation of the associated CHT- relay.

17.16 Relay R operates when relay JG0 or JG3 and an odd-numbered FUT- relay are operated, or when relay JG1, 2, or 4, and an even-numbered FUT- relay are operated. Relay L operates from JG0 or JG3 and an even FUT- or JG1, 2, or 4 and an odd FUT- relay.

Selection of the Group of Line Links(FS-46, SD-26002)

17.17 The operation of relay HG (A,B)- in the line, line link, and marker connector control circuit, as a result of horizontal group identification, connects the sleeves of the ten line links on the calling line switch to the windings of the CHT0-9 relays in the marker. A busy line link would cause the operation of the associated CHT- relay. The HGK relay in the marker operates as an indication that the HG (A,B)- has operated in the line, line link and marker connector control circuit.

Selection of a Group of Trunk Links (FS-1, SD-26032) (FS-45,46, SD-26002)

17.18 The operated F relay in the intraoffice trunk circuit operates the associated FA- (A appearance) and FB- (B appearance) relays in the trunk link circuit. The FBK relay in the marker operates as an indication that the

FB- is operated in the trunk link circuit. The operated FA or FB operates the LV6, 7, 8, or 9 (level) relay (intraoffice trunks appear only on levels 6, 7, 8, or 9).

17.19 Battery on the "BLC" lead from the marker operates the LC- (link connector) relay associated with the trunk switch where the B appearance of intraoffice trunk appears. The LCK relay operates in the marker as an indication that the LC- has operated in the trunk link circuit. Relay LC-, together with an operated L (left) or R (right) relay, extends the ten trunk links to be tested to the CHTO-9 relays in the marker; a busy trunk link would cause the operation of the associated CHT- relay.

Test Check (OS 708-1) (FS-44, SD-26002)

17.20 Before the marker proceeds with channel selection it first determines whether the necessary preliminary functions were performed. These functions are checked by the operation of relay TK (test check).

17.21 The following relays must be operated for this check to be successful:

<u>Relay</u>	<u>Functional Meaning</u>	<u>Indication</u>
FBK	(frame B appearance check)	Relay LV6, 7, 8, or 9 and an FB- relay are operated
RK or LK	(right- or left-half frame check)	Relay R or L is operated
HGK	(Horizontal group check)	Line link sleeves are closed through to the marker
LCK	(trunk link connector check)	Trunk link sleeves are closed through to the marker
JCK	(juncior connector check)	Juncior sleeves are closed through to the marker
TCHK	(test channel check)	One or more TCH- relays are operated

Channel Test (OS 706-1, 707-1, 708-1) (FS-46, SD-26002)

17.22 The channel test CHTO-9 relays are provided to test the sleeve leads associated with the selected group of junciors for a busy indication. Ground on any of the three leads associated with a particular CHT- relay indicates a busy channel and will operate the relay. The CHTO-9 relays will simultaneously test these three leads (line link, trunk link and junciors) to determine if the associated channel is busy. Therefore the operation of a CHT- relay indicates that at least one of the three linkages that make up the channel are busy and prevents the marker from selecting that channel for this call.

17.23 The windings of the CHTO-9 relays are connected to the sleeve circuit through the associated LO-9, JO-9, and TO-9 diodes, LO-9, JO-9, and TO-9 resistances through the back contacts of the CHO-9 relays and to the respective LLO-9, JO-9 and LHO-9 leads.

17.24 The diodes are used to prevent the high negative surges produced by the release of hold magnets, which had been associated with busy linkages, from reaching the winding of the CHTO-9 relays. A voltage divider effect is provided by the LO-9, JO-9, and TO-9 resistances. The LO-9, JO-9, and TO-9 capacitors reduce the transient voltages.

17.25 When the marker is normal a standing cross test is made on these leads by the XCH relay. During this period the negative side of the windings of the CHTO-9 relays is connected to the XCH relay. When the marker is off-normal the STX relay shifts the windings to battery potential.

17.26 The LL- (line link) relays do not operate during the terminating stage of the call.

Channel Selection (FS-44, SD-26002)

17.27 The CHO-9 relays are provided as channel select relays and are under control of the (channel test) CHT- and (test channel) TCH- relays.

17.28 It is necessary to delay the action of the selection CH- relay until all the CHT- relays have had sufficient time in which to operate. This delay function is performed by the operate time of the CHT (channel timer) relay.

17.29 After the TK relay operates, the CHT relay is delayed in operating until the CHT capacitor has been charged. When the capacitor is charged the effect of the secondary winding of the CHT relay is eliminated and it operates on its primary winding.

17.30 Following the operation of the CHT relay one preferred channel selection, CHO-9 relay, associated with a released CHT- relay, will be operated. This selects the connecting path associated with an idle line link, trunk link and junctor. The operated CH- relay operates the CHA and CHA1 relays. The CHA relay is used as an indication that a channel has been selected.

Channel Preference (FS-15, 44, SD-26002)

17.31 The original preference of the selection of the connecting path will be from the CHO relay being the most preferred, through the CH1 to CH8, to the CH9 relay being the least preferred. This preference will exist when the following cross connections are made.

"S"	punching	cross-connected	to	"INO"
"M"	"	"	"	"
"M1"	"	"	"	"
"E"	"	"	"	"

17.32 To equalize life of equipment the original preference of selection of the CHO-9 relays will be rotated so that the preference will be from the CH5 relay being the most preferred, through the CH6-9, through the CHO-3, to the CH4 relay being the least preferred. This preference will exist when the following cross connections are made.

"S"	punching	cross-connected	to	"IN5"
"M"	"	"	"	"OT9"
"M1"	"	"	"	"INO"
"E"	"	"	"	"OT4"

The preference is also shifted when the TR2B operates on second trial.

17.33 In order to reduce current drain the MT7 relay will be operated to release the TCHO-9 relays, after the channel has been selected and the CHA relay operated.

18. Select and Hold Magnet Operation

Select Magnet Operation (OS 709-1) (OS 710-2)

18.01 The operation of the FBK relay in the marker causes the operation of the B (level 1) and one of T6-9 select magnets through contacts of the FB-, LC- and LV- relays in the trunk link circuit.

18.02 The operation of the CH- relay in the marker which corresponds to the selected channel closes through the JS- lead to the trunk link circuit through the operated JC- relay to operate the J- select magnet.

18.03 The operation of the CH- relay in the marker also closes through the SM- lead to the line, line link and marker connector control circuit through the operated HGA relay to operate the L- and LJ- select magnets.

Hold Magnet Operation

General

18.04 Where there is an absence of ground on the sleeve conductor of any of the three linkages which comprise a channel, the marker recognizes this as an idle linkage indication and may select that channel. The marker does not know how long this channel has been idle and therefore, this channel may be selected just after it becomes idle from a previous connection, but before the hold magnets and select fingers have had time to release. To insure against trying to reoperate a hold magnet before the hold magnet and select finger have released from a previous connection, the marker is equipped with a hold magnet timing circuit consisting of the HMT (hold magnet timing) relay and the HMT1 relay. The HMT relay produces a hold magnet timing interval which is a time delay introduced into the progress of the marker to allow time for hold magnets and select fingers to release from a previous connection. The release time of a hold magnet is determined by the time required to release the armature and crosspoints, while the release time of the select finger is determined by the time required for the select finger vibration to dampen out after it has released from the trap. False operation of crosspoints would occur if the hold magnet was reoperated before this select finger vibration had dampened out.

18.05 At the completion of the hold magnet timing interval, which insures the complete release of the hold magnets and select fingers, the hold magnets will be operated. During light traffic conditions the line link frame J (junction switch) hold magnet and the trunk link frame J (junction switch) and T (trunk

switch) hold magnets will be operated immediately at the completion of the hold magnet timing interval. After these hold magnets have operated, a false cross and ground test on the tip and ring conductors will be made. After allowing sufficient time for the false cross and ground test, the marker will operate the line link frame L (line switch) hold magnet associated with the calling line.

18.06 During heavy traffic conditions the false cross and ground test will be eliminated. Therefore, in this case, all of the hold magnets, including the line link frame line switch hold magnet, will be operated at the completion of the hold magnet timing interval.

18.07 To decrease the time of operation of the hold magnets and of the marker machine time, a new feature has been added to the wire spring relay markers. With this new feature the hold magnets may be operated by the use of a momentarily applied dual voltage of 178 volts ($130 + 48$) instead of the usual 48 volts. In this case, when a hold magnet is to be operated, the marker will momentarily apply a voltage of +130 volts to the hold magnet winding. Since the other end of the hold magnet winding connects to -48 volts, this will give a total operating voltage of 178 volts, which will operate the hold magnet in about one-third the time required for 48 volt operation. Since the marker machine time is not of the greatest importance during light traffic conditions, this dual voltage operation of hold magnets will be cancelled under light traffic conditions.

18.08 To prevent falsely connecting into busy linkages associated with another connection, linkage tests are made. Before the hold magnets are operated, a test for false ground is made on the line hold magnet sleeve, the line link sleeve, the junctor sleeve and the trunk link sleeve.

18.09 After the crosspoints are closed, linkage tests are made to check the closure of the sleeve crosspoints and then an over-all check is made to insure that the connection will hold when control is shifted from the marker to the particular trunk circuit used.

Idle Check of Channel Links Before Operating Hold Magnets (FS-46, 47, SD-26002)
(OS 710-2)

18.10 An idle channel requires that the associated CHT- relay did not find ground on any of its 3 test leads. Since an open wire or dirty contact would give an idle indication, the marker makes a secondary check of the channel before operating relay HMS1 to operate the hold magnets. The secondary test is made to prevent the marker from connecting to busy channels.

18.11 The operation of the CH- relay removes the line link sleeve test leads "LLO-9" and connects the "LB-" test lead to check that the line link is idle. The LLT (line link test) relay is connected to the "LB-" lead and will operate if the line link is busy or if there is a trouble ground on the lead.

18.12 After the particular channel is selected, the operated CH- relay will disconnect the CHT- relay from the sleeve test leads and connect the "J-" lead (junctor sleeve) to the JGCK (junctor ground check) and the "LH-" lead, (trunk link sleeve) to the TGCK (trunk ground check) relays in series with the Junctor and Trunk Link Hold Magnets.

18.13 To check that the LL junctor switch hold magnet is idle and its operating circuit is free of trouble grounds, the JGCK relay will operate, in series with the idle junctor switch hold magnet. Because of the high resistance of the JGCK relay, the hold magnet does not operate. In the same manner, if the trunk link junctor switch and trunk switch hold magnets are idle and their operating circuit is free of trouble grounds, the TGCK relay will operate.

18.14 If all of the linkages are idle and if all of the operating circuits are free of trouble grounds, the associated JGCK and TGCK relays will be operated and the LLT and LLTA relays will not be operated. This provides an operating circuit for the HMS1 relay when the hold magnets are to be operated. If any of the linkages are busy or if any of the operating circuits have trouble grounds, the associated JGCK or TGCK relay will not be operated or the LLT and LLTA relays will be operated. Therefore, in this case, the HMS1 relay will be prevented from operating to block the hold magnet operation. The marker will time-out and a trouble record will be taken.

18.15 To indicate that all of the check relays are released before their use is required, the SLRK relay was operated. If one of the check relays is falsely held operated before its use, the SLRK relay will not operate which in turn will prevent the operation of one of the CHO-9 relays. The marker will time out and a trouble record will be taken.

Hold Magnet Timing and Control (FS-47, SD-26002) (OS 710-2)

18.16 After the selection of a connecting path, the marker will delay the operation of the hold magnets. Sufficient time is allowed for the select magnets to fully operate and for the full release of any previously operated hold magnet. The desired hold magnet may have released just prior to the operation of the CHO-9 relay and will be reoperated in setting up this connecting path. The time delay in the operation of the hold magnets is to prevent double connections caused by closing two crosspoints by the operation of one hold magnet. This time delay function is performed by the condenser timed HMT (hold magnet timing) relay and the HMT1 (hold magnet timing auxiliary) relay.

18.17 Battery has been extended to both the primary and secondary windings of the HMT relay. With the CHA relay nonoperated, ground has been extended to bias the secondary winding of relay HMT to the nonoperated position and ground has been extended through resistance to bias the primary winding of relay HMT to the operated position. However, the effect of the secondary winding predominates and relay HMT will remain in the nonoperated position. When the CHA (channel auxiliary) relay operates the effect of the secondary winding is eliminated and relay HMT operates. Due to the momentary current flow in the secondary winding caused by the HMT condenser charging, the HMT relay operation is delayed for a short period of time. The operation of relay HMT will operate the HMT1 relay.

18.18 If the linkage test LGCK, JGCK and TGCK relays are operated, relay HMT1 will operate the HMS1 (hold magnet start) relay. The proper operation or nonoperation of these linkage test relays indicates that no false crosses or grounds exist on the linkages tested.

Hold Magnet Operation - Light Traffic

18.19 During the light traffic condition the dual voltage operation of the hold magnets will be cancelled and relay DVO is nonoperated. Also, the operation of the line link frame line hold magnet will be delayed until after the false cross and ground test.

Operation of Trunk Switch and Junctor Switch Hold Magnets - Trunk Link Frame (FS-46, 47, SD-26002) (OS 709-1) (OS 710-2)

18.20 The operation of relay HMS1 will operate the one trunk link frame J hold magnet (when extension trunk link frame junctor switches are provided two hold magnets will be operated) and the one trunk link frame T hold magnet associated with the selected connecting path.

18.21 The windings of the trunk link frame T and J hold magnets which are associated with the same trunk link frame trunk link are interconnected by means of the associated trunk link frame trunk link sleeve conductor. The ten trunk link frame trunk link sleeve conductors associated with the ten selected channels have been extended to the marker over the "LHO-9" leads. Within the marker, the one "LH" lead associated with the selected connecting path will be extended through the one operated CHO-9 relay contact to ground when relay HMS1 operates.

Operation of Junctor Switch Hold Magnet - Line Link Frame (FS-46, 47, SD-26002) (OS 710-2)

18.22 The operation of relay HMS1 will operate the one line link frame switch hold magnet associated with the selected connecting path.

18.23 The windings of the line link frame J hold magnets are connected to the junctor sleeve leads which are extended to the trunk link frame. These sleeve leads are further extended to the marker over the "JO-9" leads. Within the marker, the one "J" lead associated with the selected connecting path will be extended through the one operated CHO-9 relay contact to ground (through the JXP relay primary winding) when relay HMS1 operates.

Operation of Line Hold Magnet - Line Link Frame (FS-46, 47, SD-26002) (OS 710-2)

18.24 During light traffic conditions, the marker will perform a false cross and ground test on the tip and ring conductors of the selected connecting path. A light traffic condition will be indicated by relay HTR being nonoperated. This false cross and ground test is made after the line link frame J hold magnet and the trunk link frame J and T hold magnets have operated but before the line link frame L hold magnet is operated. After the line link frame J hold magnet and the trunk link frame J and T hold magnets have operated, sufficient time must be provided for the false cross and ground test before the line link frame L hold magnet operation may start.

18.25 After the line link frame J hold magnet and the trunk link frame J and T hold magnets have operated, the linkage check SLA, LLTA, and JXP1 relays will operate as described in following paragraphs. The operation of these relays with the HTR (heavy traffic) relay nonoperated will operate the LTR (light traffic) relay. The operation of relay LTR will operate the GLH relay, which in turn will operate the GLH1 relay.

18.26 The LTR relay is a slow operating relay so that if there is a false cross of the tip and ring conductors, a false ground on the ring conductor, or a false battery on the tip conductor, the FCG (false cross and ground detection) relay will have sufficient time in which to operate. The operation of relay GLH will remove the FCG relay from the tip and ring conductors. When relay GLH operates, the charge due to the capacitance of the tip and ring conductors is discharged through the GLH resistance.

18.27 The operation of relay GLH1 will operate the line switch hold magnet associated with the calling customer. The windings of the five line switch hold magnets associated with the customers within the selected line group of five lines are extended to the marker over the "LHO-4" leads. Within the marker, the one "LHO-4" lead associated with the selected vertical file will be extended to ground through the operated VFTO-4 relay contact (through the LXP relay primary winding) when relay GLH1 operates.

Hold Magnet Operation - Heavy Traffic (OS 710-2)

Dual Voltage Operation

18.28 During a heavy traffic condition, the hold magnets will be operated by dual voltage in offices not equipped with message registers. If the dual voltage operation was used when there were customer message registers on the Line Link Frame, it might be possible to falsely operate the registers.

18.29 During the hold magnet timing interval the +130 volt battery will charge either one 4.32 MF or two 4.32 MF capacitors to +130 volts. When a hold magnet is to be operated, the +130 volts on the capacitor is extended from the marker to the winding of the hold magnet. The +130 volt charge on the capacitor will then be discharged through the hold magnet. The capacitor discharge current will operate the hold magnet very quickly. When the voltage across the capacitor drops to about -.5 volts the diode will become conducting and will supply the steady current flow to hold the hold magnet operated.

18.30 To indicate that the hold magnets should be operated by dual voltage (-48v. and +130v.) the DVO (dual voltage operation) relay will be operated when relay HTR operates.

18.31 One side of the LH, JH, and TH capacitors are connected to ground through either the LXP or JXP relay or TXP lamp. When relay CHA operates and the DVO relay is operated, the +130 volt battery will charge the other side of the capacitors to +130 volts. The operation of the HMT1 relay will open these charging circuits. While the capacitors are charging, the LH, JH, and TH diodes are not conducting current and will have no effect.

Operation of Trunk Switch and Junctor Switch Hold Magnets - Trunk Link Frame (FS-46, SD-26002) (OS 710-2)

18.32 The operation of relay HMS1 will operate the one trunk link frame J hold magnet (when extension trunk link frame junctor switches are provided two junctor switch hold magnets will be operated) and the one trunk link frame, T hold magnet associated with the selected connecting path.

18.33 The windings of the trunk link frame J and T hold magnets have been extended to the marker over the "LHO-9" leads. Within the marker, the one "LH" lead associated with the selected connecting path will be extended through the one operated CHO-9 relay contact to the +130 volts on the JH capacitor when the HMS1 relay operates. When the voltage on the capacitor drops from +130 volts to about -1/2 volt, the JH diode will become conducting and will supply the steady current necessary for holding the hold magnet operated.

Operation of Line Hold Magnet - Line Link Frame (FS-46, 47, SD-26002) (OS 710-2)

18.34 During heavy traffic conditions the marker will not perform a false cross and ground test but will operate the line hold magnet immediately after the hold magnet timing interval.

18.35 The operation of relay HMS1 will operate the line link frame L hold magnet associated with the calling customer's line.

18.36 The windings of the five line link frame L hold magnets associated with the customers within the selected line group are extended to the marker over the "LHO-4" leads. Within the marker, the one "LHO-4" lead associated with the selected vertical file of the calling customer, will be extended through the one operated VFTO-4 relay contact to the +130 volts potential on the LH capacitor when relay HMS1 operates. When the voltage on the capacitor drops from +130 volts to about -1/2 volt, the LH diode will become conducting and will supply the steady current necessary for holding the hold magnet operated.

Sleeve Crosspoint Check After Operating Hold Magnets (FS-46, 47, SD-26002) (OS 710-2)

18.37 To indicate that all sleeve crosspoints are operated, the SLA, LLTA, JXPl, and LXPl relays will be operated.

Trunk Switch Crosspoint Check - Trunk Link Frame

18.38 When the trunk link trunk switch hold magnet operates, the ground (or +130 volts) which has operated the hold magnet will be extended through the operated sleeve crosspoints and over the "AST" or "BST" lead to the marker, thereby operating the SL relay. The operation of relay SL will operate the SLA relay.

Junctor Switch Crosspoint Check - Trunk Link Frame

18.39 The current for operating the line link junctor switch hold magnet will flow through the primary winding of the JXP relay, thereby operating this relay. The operation of the JXP relay will operate the JXPA relay. When the trunk link junctor switch hold magnet operates, the ground (or +130 volts) which has operated the hold magnet will be extended through the operated sleeve crosspoint and over the "JO-9" lead to the marker, and to the windings of the JXP relay. This ground (or +130 volts) applied to the windings of the JXP will result in the release of this relay. The release of the JXP relay, with the JXPA relay operated, will operate the JXPl relay.

Junctor Switch Crosspoint Check - Line Link Frame

18.40 When the line link junctor switch hold magnet operates, the ground (or +130 volts) which has operated the hold magnet will be extended through the operated sleeve crosspoint and over the "LBO-9" lead to the marker, thereby operating the LLT relay. The operation of relay LLT will operate the LLTA relay.

Junctor Switch and Line Switch Crosspoint Check - Line Link Frame

18.41 The current for operating the line link line switch hold magnet will flow through the primary winding of the LXP relay thereby operating this relay. The operation of relay LXP will operate the LXPA relay. When the trunk link junctor switch hold magnet operates, the ground (or +130 volts) which has operated the hold magnet will be extended over the sleeve junctors to the line link. When the line link junctor switch and line switch line hold magnets operate, this ground (or +130 volts) will be further extended through the operated sleeve crosspoints and over the "LHO-4" lead to the marker and to the windings of the LXP relay. This potential applied to the winding of the LXP relay will result in the release of this relay. The release of the LXP relay, with the LXPA relay operated, will operate the LXPl relay.

18.42 The operation of the LXPl, JXPl, and SLA cuts in the DCT relay for making the double connection test and closes a circuit for controlling the LTR and GT1 relays.

19. False Cross-Ground Test (FS-48, SD-26002)

19.01 During light traffic conditions the marker operates the line link J hold and the trunk link J and T hold magnets except the line hold magnet and momentarily applies the FCG, false cross-ground test relay to the tip and ring leads, before completing the connection.

19.02 The FCG relay is a sensitive double wound relay, with ground on one winding and battery on the other winding. The operation of the FCG relay will indicate a false cross between the tip and ring conductors, a false ground on the ring conductor or a false battery on the tip conductor.

19.03 The primary winding of the FCG relay is extended over the "ART" or "BRT" lead from the marker to the trunk link and through the operated trunk link trunk switch and junctor switch hold magnet crosspoint contacts and over the ring conductor of the junctor to the line link frame, through the operated line link junctor switch hold magnet crosspoint contact and over the ring conductor of the line link to the nonoperated line link line hold magnet crosspoint contacts.

19.04 The secondary winding of the FCG relay is extended over the "ATT" or "BTT" lead from the marker through the trunk link and over the tip conductor of the line link to the nonoperated line link line hold magnet crosspoint contacts in a similar manner as above.

19.05 If there is a false ground on the ring conductor at any point from the nonoperated line link line hold magnet crosspoint contacts to the primary winding of the FCG relay, the FCG relay will be operated by a current flow in

the primary winding. If there is a false battery on the tip conductor at any point, the FCG will operate from the current flow in the secondary winding. If there is a false cross between the tip and ring conductor at any point the FCG relay will operate by a current flow in both the primary and secondary windings.

19.06 The FCG relay in operating will lock operated when the LTR, light traffic relay operates. This will prevent the GLH (ground line hold magnet relay) from operating), blocking the call, and forcing a timeout and a trouble record.

19.07 If the FCG relay is nonoperated, indicating that no trouble was encountered, the operation of the LTR relay will operate the GLH relay. The GLH relay operates the GLH1 relay to operate the line hold magnet. During the time the GLH1 relay is operating the tip and ring conductors will both be grounded to discharge any conductor capacity and prevent false operation of the continuity test.

20. Continuity Test (FS-48, SD-26002)

20.01 The continuity test is made to check that all crosspoints of the selected channels are closed and does not require an off-hook condition to complete satisfactory test.

20.02 The continuity test is made only when light traffic conditions exist in the office.

20.03 The operation of the line link frame and trunk link frame hold magnets extend the tip and ring conductors of the line through the selected channel to the marker and initiates the continuity test. Ringing voltage of 20-cycle frequency is applied to the primary of the CON2 repeating coil, which by its transformer action, steps up the voltage. This voltage from the secondary is applied to a series circuit consisting of the CON2 capacitor, the channel crosspoints, and the line. Before the line switch crosspoints are closed by the operation of the line hold magnet the series circuit is open, therefore, no current flows in the repeating coil secondary circuit and the voltage drop across the CON2 capacitor is zero. The operation of the line hold magnet to close the line switch crosspoints completes the path for the CON2 repeating coil secondary, therefore alternating current flows from its secondary circuit through the CON2 capacitor, and through the channel crosspoints and the line.

20.04 The current flowing in the CON2 capacitor, repeating coil secondary, channel crosspoints and line causes the voltage of the secondary to be divided across the CON2 capacitor and the line, the amount of voltage across each being determined by the impedance of each. The impedance of the subscriber line is relatively low compared with the impedance of the CON2 capacitor, and therefore the greater portion of the voltage from the CON2 repeat coil secondary will appear across capacitor CON2. This voltage across the CON2 capacitor is sufficient to break down the control gap of the CON tube, which is connected across capacitor CON2. The breakdown of the control gap results in the main gap becoming conductive and the CON (continuity) relay operating in series with the main gap of the CON tube. If one of the channel crosspoints fails to

close, the current through capacitor CON2 is determined by leakage in the central office local cabling and other circuit elements but is insufficient to cause the breakdown of the control gap of the CON tube.

20.05 For the condition of a false customer start the continuity test must not result in a false continuity test failure if at the time of the continuity test the customer's receiver is on the switchhook. When the receiver is off the switchhook a continuity test current is extended through the operated switchhook contacts from either the ring conductor to the tip conductor or from the tip conductor to the ring conductor according to the setting of the reverse continuity test relays. However, if the receiver is on the switchhook, because of a false customer start, the continuity test current may be extended through the customer's ringing. If the calling party keeps the receiver off the switchhook, the continuity test will check on individual customer lines and on multiparty customer lines regardless of which party is calling. If the receiver is on the switchhook when the continuity test is made, because of a false customer start, the continuity test will check on the individual customer lines. However, to check the continuity of a 2-party customer's line under a condition of a false customer start, the test of the conductors might have to be reversed after the first test indicated failure because the calling customer's ringer may be on the opposite conductor.

Operation of the CON Tube and CON and CONA Relays (FS-48, SD-26002)

20.06 The CON relay in operating will check and indicate that a successful continuity test has been performed. The winding of the CON relay is in series with the anode circuit of the CON vacuum tube. When the CON tube becomes conductive the CON relay will operate on the current flow from +130 volts through the CON8 resistance, through the winding of the CON relay, from the CON tube anode (terminal #2) to the CON tube cathode (terminal #4) and to ground. The CON tube will become conductive if the voltage on the control anode (terminal #1) exceeds approximately +72 volts. Therefore, to indicate a successful continuity test a voltage will be applied to the control anode of greater than +72 volts.

20.07 The operation of the frame "A" or "B" appearance relay, the level relay, and the connector cut-through relay in the trunk link have extended the tip conductor of the selected channel over the "ATT" or "BTT" lead to the marker, and the ring conductor over the "ART" or "BRT" lead to the marker. The tip and ring conductors will alternately be connected to ground and to the CON2 repeating coil according to the setting of the RCTA (reverse continuity test relay). The tip or ring conductors will be extended to ground with the FAK or FBK relay operated, the GT1 relay nonoperated, the GLH1 relay operated, through the RCTA contacts according to the setting of the reverse continuity relay will be extended with the FAK or FBK relay operated, the GT1 relay nonoperated, the GLH1 relay operated, through the RCTA relay contacts, through the CON6 resistance, the CONA relay nonoperated, the CON1 retard coil, the secondary of the CON2 repeating coil, through the CON2 capacitor (for a 20-cycle frequency ringing current) to ground on the "RING G" lead.

20.08 The operation of the CHA relay has applied ringing potential to the primary winding of the CON2 repeating coil which is a step-up transformer. A 20-cycle stepped-up voltage is induced in the secondary winding and this voltage is used to test the continuity of the circuit and to operate the CON tube.

20.09 The operation of the line link and trunk link hold magnets has extended the tip and ring conductors over the calling customer line to the customer set. Therefore, after the trunk link and line link crosspoints have closed, the 20-cycle voltage will cause a current to flow through the line and charge the CON2 capacitor. The voltage drop across the CON2 capacitor is determined by the ratio of the impedance of the capacitor as compared to the impedance of the customer's line. With continuity over the tip and ring conductors the voltage drop across the CON2 capacitor will be large enough to break down the CON tube, as the impedance of the customer's line is relatively small as compared with the CON2 capacitor impedance.

20.10 If there is an open condition at any of the crosspoints or in any of the cabling within the office in the continuity check path the 20-cycle ringing current which will flow will be very low, being controlled by the capacity and leakage of the switches and cables. Therefore, the voltage drop across the CON2 capacitor due to this current flow will be very low and will be less than the voltage required to cause the breakdown of the control anode gap of the CON tube. Thus the CON relay will not operate.

20.11 The operation of the CON relay will operate the CONA relay which will operate the CON1 relay. The operation of the CON1 relay indicates that the continuity test had been satisfactorily completed.

Operation of the RCTA and RCTB Relays (FS-48, SD-26002)

20.12 The continuity test on the customer line is made by the marker when it establishes the connection. The RCTA relay operated or released will direct the marker to the side of the line that is to be tested first. Continuity test is arranged to be made over the ring side of the line with the marker supplying the return ground on the tip side when the RCTA relay is nonoperated. When party lines are involved, the RCTA relay is operated for either originating or incoming calls to a tip party line or when a call is originated from a multiparty line. The marker is not informed which side of the line to test when a call is originated from a multiparty line and therefore, the marker will test on the ring side first. This arrangement generally gives successful continuity test because the originating customer has the receiver off the switchhook.

20.13 However, the customer may have abandoned the call after the marker has been engaged and the receiver will be back on the switchhook. The abandoned call cannot be recognized until the channel is cut through to the register. Thus the marker makes continuity test to the line after the dc bridge of the transmitter has been opened. If the line is individual class of service (bridged ringer) the continuity test will be successful, as it will be made through the customer's ringer. If the line is a party line the continuity test will be successful if the customer's ringer to ground is on the side of the conductor that is being tested. However, if the customer's

ringer is on the conductor that is not being tested, the continuity test may fail. It will be then necessary to switch the continuity test to the other conductor in order to operate the CON tube through the customer's ringer. The continuity test is designed so that it will not fail on abandoned calls.

20.14 On any call-forward linkage connection, the setting of the ringing combination informs the marker which side of the line the station ringer is located. Relay RCTA will operate when the RCT7, 9, 11-15 relay (tip party ringing combination) operates.

20.15 During a call-back linkage the RCTB relay will operate from the ground through the HTR relay contacts normal and will prevent the RCTA relay operation for ring party stations. During continuity test of a multiparty line the ring side of the line is tested first. When the line crosspoint LXPL relay operates it starts the release of the RCTB relay. If continuity test is satisfied, the operation of the CON1 relay will lock the RCTB relay operated. If continuity test is not satisfied the RCTB relay will release and cause the RCTA relay to operate which will reverse the continuity test to the tip conductor.

21. Ground, Loop, and Receiver-off-Hook Tests

General

21.01 "Ground test" is made by the marker on any called customer line over the tip and ring conductors if the line is a non-PBX and nonground start coin line. The test is made from the trunk link trunk switch to the line link line switch and to the customer set to detect a false conductor. "Loop test" is made by the marker on a called PBX line over the tip and ring from the trunk link trunk switch to the PBX switchboard. It will detect a false cross between the tip and ring, or a plug in the jack at the PBX switchboard. The "Receiver-off-hook test" is made on the tip and ring conductors from the trunk link trunk switch to the coin station of a ground start coin line. It will detect a false ground on the tip or a false cross between the tip and ring.

GTL Relay (FS-47, SD-26002)

21.02 The ground test GTL-2 relays will be operated when the line link line and junctor switch crosspoints have operated and the trunk link trunk and junctor switch crosspoints have operated, if a heavy traffic condition exists. However, during light traffic conditions it will also be necessary for the continuity test to be completed before the GTL relay will be operated.

21.03 Under heavy traffic conditions the CGT (cancel ground test) relay will be operated when the GTK relay operates (FS-48, SD-26002). The CGT relay operated will open the operating path for the GT relay thereby cancelling ground test.

21.04 To indicate that the called line is a PBX line and therefore a loop test should be made instead of ground test, the LGT relay is operated. The CKR relay which operates only when the called line is a PBX line will operate the LGT relay which will transfer the operate path for the GTK relay through the operated LGT, PBXA and CKR relays. Relay LGT will also prevent the CGT relay from operating and insuring that loop test is made for both light and heavy traffic conditions.

21.05 To indicate that the called line is a ground start coin line and therefore a receiver-off-hook test instead of a ground test should be made, the LGT relay will operate when the CN relay operates. The GTK relay will in this case operate through the operated LGT relay and the nonoperated AOC relay. This test will be made under both light and heavy traffic conditions.

GT Relay (FS-48, SD-26002)

21.06 The GT relay is provided to indicate the success or failure of the ground, loop, or receiver-off-hook test. The customer line will be tested on the basis of holding the GT relay operated if the line test is not satisfactory. If the line test is satisfactory the GT relay will be released permitting the marker to proceed and to operate the DCTL relay if the double connection test is satisfactory.

21.07 The tertiary winding of the ground test GT relay is energized by the operation of the LLC3 relay which operates the GT relay in the non-operated position. The operation of the GTK relay with the GT2 relay non-operated will extend ground to the primary winding of the GT relay thereby operating the GT relay to the operate position.

Ground Test

21.08 When "ground test" is being made the primary winding of the GT relay is extended to the tip and ring conductors over the "ART or BRT" and "ATT or BTT" leads which are extended to the trunk link and then to the tip and ring of the selected connecting path. The operation of the GT2 relay will remove the local operating ground from the primary winding of the GT relay. Therefore, the primary winding is only connected to the tip and ring of the called line. The GT relay will hold operated if there is a false ground on the tip or ring of the customer line. A successful ground test is indicated by the release of the GT relay.

Loop Test

21.09 When "loop test" is being made the primary winding of the GT relay is extended to the tip over the "ATT or BTT" lead which is extended to the trunk link and then to the tip conductor of the selected connecting path. Ground is extended over the "ART or BRT" lead to the ring through the PBXA and LGT relays operated. The operation of the GT2 relay will remove the local operate ground from the primary winding of the GT relay. Therefore, the primary winding will be connected only to the tip of the called line. The GT relay will hold operated if there is a false ground on the tip, a false cross between the tip and ring, or if there is a plug in the jack at the PBX switchboard.

Receiver-off-Hook Test

21.10 When "receiver-off-hook test" is being made, the primary winding of the GT relay is extended to the tip over the "ATT or BTT" lead which is extended to the trunk link and to the tip of the selected path. Ground is extended through the PBXA relay nonoperated and the LGT relay operated and through the winding of the PU relay over the "ART or BRT" lead to the ring conductor. The operation of the GT2 relay will remove the local ground from

the primary winding of the GT relay, therefore, the primary winding is only connected to the tip of the called line. Relay GT is held operated if there is a false ground on the tip or a false cross between the tip and ring conductors.

22. Double Connection Test (FS-47, SD-26002) (OS 710-2)

22.01 The double connection test DCT relay will test the sleeve conductor associated with the selected path for false ground. If a double connection or cross exists between two sleeves, ground will be transferred from the busy sleeve to the other sleeve.

22.02 The operation of the LXPl, JXPl, and SLA relays transfer the holding ground for the line link and trunk link hold magnets to the "LHO-4" leads from the line link. This holding path is in series with the primary winding of the DCT relay and all the hold magnet current will pass through the DCT relay, if the sleeve is not falsely grounded.

22.03 The DCT relay has a secondary or biasing winding which has a current flowing through it in such a direction as to hold the relay nonoperated. Thus the DCT relay will only operate, when the hold magnet holding current passes through the primary winding.

22.04 When the DCT relay operates it indicates that the double connection test is satisfactory and there are no false grounds on the sleeve lead. The operation of the DCT will operate the double connection test auxiliary DCT1 relay. Before the DCT1 relay is operated, the ground test circuit is checked for proper operation.

22.05 A satisfactory ground test check is indicated when the GT2 and GTA relays operate, with the GTK relay operated.

22.06 The operation of the DCT1 relay does not release the F relay in the trunk on the terminating stage. Relay F is held operated through the operated ITR2 and nonoperated DCT2 relays in the marker. The operation of relay DCT1 connects ground to the BST lead to hold operated the hold magnets associated with the connecting path to the called line.

23. Release of the Select Magnets (OS 710-2)

23.01 The GT1 relay will be operated when all crosspoints are closed if a heavy traffic condition exists. If a light traffic condition exists continuity test must be completed before the GT1 operates. When it does operate and with the DCT1 relay operated the ONX (off-normal cross) relay will release. This will cause the release of all the select magnets.

24. Linkage Check Circuit

24.01 Before the marker gives the release indication it will check that the connecting path through the crosspoints has been tested to determine that it is in condition for service. A satisfactory linkage check indicates that the marker can release and will be available for other connections.

24.02 The linkage check circuit checks the following:

- (a) Double Connection Test - Which indicates that there is no false ground on the sleeve conductor of the connecting path, no double connection.
- (b) Ground Test or Line Test - This test is made to prevent false charging of the calling customer when the connection cannot be completed.
- (c) RNG Relay - Indicates that the number group has been released after the called line location has been recorded in the marker.
- (d) RSK Relay - Indicates that the ringing selection switch has been set up.

24.03 When double connection test has been completed, relay DCT (double connection test) releases and operates the LK1 and LK2 (linkage check) relays in series (FS-49, SD-26002). The operation of the linkage check relays indicates the completion of the call-forward linkage in which the called line was connected to the B appearance of the intraoffice trunk. At this point the marker will recycle its functions and will attempt to establish the call-back linkage.

C. ESTABLISHING THE ORIGINATING CONNECTION - CALL-BACK LINKAGE

1. General

1.01 Establishing the originating connection consists of the selection and connection of a channel between the A appearance of the intraoffice trunk and the calling line. Before the marker does this, however, it releases certain relays that it used when establishing the terminating connection.

1.02 Then the marker, through the line link connector, selects the line link frame on which the calling line is terminated. The calling line identification was made when the dialing connection was established and the information was stored in the originating register during dialing. This information is now used by the marker for selecting the ten line links available to the calling line. Since the marker is already connected to the trunk link frame on which the intraoffice trunk is terminated, it has access to the junctor and trunk link test leads. By the use of these and the ten line link test leads, the marker tests for and selects an idle channel. For purposes of this test, the channel connecting the calling line and the originating register (dialing connection) is considered idle.

1.03 After channel selection, the dialing connection is released and the marker establishes the originating connection from the A appearance of the intraoffice trunk to the calling line. The trunk then assumes control of the connection. The marker and register are now released.

2. Release of Certain Relays Used in the Terminating Connection - Call-Forward Linkage

2.01 The operation of relays LK1 and LK2 (linkage check) indicates the completion of the terminating connection. These relays, together with the FLG, FLG1 (first linkage ground), LLC1, LLC2 (line link control) relays that are released by the operation of relay LK1, perform the following functions:

- (a) Release the MP- (marker preference) relay in the preference control and make-busy circuit.
- (b) Release the line link connector that connects the marker to the line link frame on which the called line is terminated.
- (c) Release the marker relays that were operated by the number group to indicate the equipment location of the called line.
- (d) Release the marker relays that operated to select the connecting path from the B appearance of the trunk to the called line.
- (e) Step the marker sequence walking circuit.

3. Start of the Call-Back Linkage

- 3.01 The marker must release all of the registered number group information that was used on the call-forward linkage. When this occurs and the LK1 relay operates the CB and CBI (call-back) relays will operate. These in turn cause the operation of the CB2, 3, 4, and 5 (call-back) relays.
- 3.02 The operation of the CBI relay will cause the operation of the SCBI and SCB2 (start call back) relays if the channel check relays have all been released (FS-33, SD-26002). The CB2 relay operates the LOT (LO lead start) relay.
- 3.03 The operated CB relay reoperates the LLC1 relay and the SCBI relay reoperates the LLC2 and LLC3 relays (FS-33, SD-26002).

4. Selecting the Connecting Path to the Calling Line

General

- 4.01 The operations for this part of the intraoffice call are similar to those for the dial tone connection. In this part, however, it is not necessary for the marker to identify the calling line. This was done when the dialing connection was established. The marker received this information from the originating register while setting up the call-forward linkage and now uses it to select the desired line (see Paragraph B-6).

Selecting the Line Link Frame

- 4.02 The operated CB and CBI relays, together with the one operated FT- (frame tens) and two out of five operated FU- (frame units) relays, operate one FTT- and one FUT- relay in the marker (FS-3, 4, SD-26002). These latter two relays complete a path from battery to the associated ST- lead to the MP- (marker preference) relay chain in the preference control and make-busy circuit (FS-5, SD-26002) for the selected line link frame (see Paragraph B-13). The operation of relay MP- seizes the line link frame by causing the operation of the marker connector relays in the associated line link connector. These relays provide connections between the marker and the line link frame.

Selecting the Vertical Group (FS-6, 9, SD-26002) (FS-2, SD-26030)

4.03 The operated CB3 and CB4 relays, in combination with two out of six VG- (vertical group) relays, operate the VGT- relay that corresponds to the calling line vertical group. The operation of one VGT- relay operates the VTK1 (vertical group test check) relay. The operation of relay VTK1 is a check that one and only one VGT- relay is operated. The operation of relay VTK1 with one VGT- relay operated extends battery to the line link frame on the VGB- lead to operate the corresponding VGB- relay.

Selecting the Horizontal Group (FS-7, 9, SD-26002) (FS-2, SD-26030)

4.04 The operated CB3 relay in combination with two out of five HG- (horizontal group) relays, operate the HGT- relay that corresponds to the calling line horizontal group. The operation of one HGT- relay operates relay HTK1 (horizontal group test check), which checks that one and only one HGT- relay is operated. With relay LLC1 operated, the operation of relays HGT- and HTK1 place battery on one HG- lead to the line link frame to operate relays HGA- and HGB-.

Selecting the Line Hold Magnet (FS-5, 8, SD-26002) (FS-1, SD-26030)

4.05 The marker provides battery over the BS lead to the line link frame. This battery is passed through contacts on the operated VGB- and HGA- or HGB- relays to operate relay LG- on the line link frame. The operation of relay LG- extends five LH- leads from the line link frame to the marker. The operation in the marker of the CB2 relay, in combination with one out of five VF- (vertical file) relays, operates relay VFT-. Relay VFT- operates relay FTK1 (vertical file test check) as a check that one and only one VFT- relay is operated. The operation of relay VFT- in conjunction with relay FTK1 completes the selection of the line hold magnet connected to the calling line.

Selecting the Line Link Test Leads (FS-1, SD-26030)

4.06 The operation of relay HGB- extends ten LL- leads from the line link sleeves to the CHT- (channel test) relays in the marker (FS-1, SD-26030) (FS-46, SD-26002). Busy line links are grounded; therefore, the CHT- relays that correspond to busy line links operate.

4.07 The dialing connection is released before the originating connection is established. Therefore, the line link used in the dialing connection is also available for use in the originating connection. In order that it may be selected, it must be made to appear idle on the channel test for the originating connection.

4.08 The originating register has stored the number of this line link. It passes this number to the marker and operates two out of five LL- relays (FS-46, SD-26002). The operation of these two relays opens the LL- test lead that corresponds to this line link. This makes the line link appear idle by preventing the operation of relay CHT- (FS-46, SD-26002). The operation of two out of five LL- relays also completes the path for the operation of the RK1 and RK2 (registration check) relays (FS-2, SD-26002). The operation of relays RK1 and RK2 indicates that the calling line information and channel number of the dialing connection are recorded in the marker. To verify this, the RK3 (registration check) relay operates.

Selecting the Junctor Subgroup

4.09 The operated FT-, and CB relays operate the FTB- (frame tens auxiliary relay that corresponds to the frame tens digit of the line link frame (FS-4, SD-26002)). This relay, in combination with the FUT- relay that corresponds to the line link frame units digit, operates a P- (pattern) relay if the junctor subgroup contains less than ten junctors (FS-14, SD-26002) (FS-4, SD-26033). The remainder of the junctor subgroup selection is the same as explained in Paragraph B-17. The operation of a JC- relay at the end of the subgroup selection extends a group of ten junctor test leads from the junctor subgroup sleeves to the CHT- (channel test) relays in the marker. The CHT- relays that correspond to busy junctors operate.

Selecting the Group of Trunk Links

4.10 The operation of relay LK1 releases the LC- relay that corresponds to the trunk switch connecting to the B appearance of the trunk (FS-47, SD-26002). The operation of relay SCB2 operates the LC- relay that corresponds to the trunk switch connecting to the A appearance of the trunk. Since both appearances of the trunk are on the same level, although on different switches, the same LV- relay remains operated.

4.11 The operation of relay LC- connects a group of ten trunk link test leads from the trunk switch to the CHT- relays in the marker (FS-46, SD-26002). The CHT- relays that correspond to busy trunk links operate.

Test Check and Channel Selection

4.12 The marker then makes the test check and channel selection, as described in Paragraph B-17.

5. Release of the Dialing Connection

5.01 The operation of relay CHA (channel selection auxiliary) at the end of channel selection operates relay RL (release) in the originating register (FS-51, SD-26002). This relay, in operating, opens the 10-ohm ground on the sleeve circuit of the established dialing connection (FS-1, SD-26040). The hold magnets on the line link and trunk link frames release.

6. Dial Tone Lockout

6.01 The release of the line hold magnet during the interval between the release of the dialing connection and the setting up of the originating connection allows relay L- (line) to operate. Relay L- operates the VGS- (vertical group start) relay that corresponds to the vertical group of the calling line. If there are no other customers on this line link frame who are waiting for dial tone, relay VGS- starts the seizure of a dial tone marker. This marker then attempts to establish another dialing connection for this customer. In order to detect and prevent this condition, the dial tone lockout circuit is used.

6.02 At the start of the originating connection, relay CB2 operates relay LOT (OS 728-1). During channel selection, relay TCHK (test channel check) operates. These relays extend ground on the G lead to the line link frame (OS 728-1). If there is a customer connected to this frame who has already requested dial tone, relay DT (dial tone) is operated. The ground passes through the operated DT relay contacts and operates relay DTK (dial tone check) in this marker, and in addition, places ground on the DTK lead to any other marker that is connected to this frame. A dial tone marker, in responding to the dial tone request, is connected to the frame through the line link marker connector. The grounded DTK lead operates its DTK relay, which prevents relay HGG (horizontal group gate) from operating (OS 728-1). This prevents relay GK (gating check) from operating, and therefore, prevents this marker from making line identification. This keeps the marker from identifying the line to which the originating connection is being made. If, however, relay GK has operated and locked, relay DTK releases relay HGG and prevents horizontal group identification. In either case, the setting up of the originating connection and the consequent release of relay L- makes it possible to release the DTK relays by the release of relay ONX (OS 728-1). The setting up of the dialing connection then proceeds.

6.03 If there are no customer requests for dial tone at the time relay TCHK operates, the ground is passed through the nonoperated contacts of relay DT and operates relay LOT1, which locks. Relay LOT1 operates relay LO (lockout). Relay LO opens the start leads, thereby preventing marker seizure by the frame until relay ONX releases LO at the conclusion of the originating connection.

7. Select and Hold Magnet Operation

7.01 The operation of the FAK relay in the marker causes the operation of the A (level 0) and one of T6-9 select magnets through contacts of the FA-, LC- and one of LV6-9 relays in the trunk link circuit.

7.02 The circuit action from this point will be the same as explained in Paragraph B-18.

8. Continuity Test

8.01 This test is the same as that described in Paragraph B-20.

9. Double Connection Test

9.01 The double connection test to the calling line is similar to that described in Paragraph B-22. However, relay DCT1 which operated and locked on the call-forward connection is not used again. It provides sleeve holding ground for the call-forward (terminating) connection, and therefore must remain operated (FS-46, 47, SD-26002).

9.02 If the double connection test is successful then the DCT2 relay will operate in the marker (FS-49, SD-26002).

10. Transfer of Connecting Path Supervision to the Intraoffice Trunk

10.01 The operation of relay DCT2 at the conclusion of the double connection test removes the operating ground from the F relay in the intraoffice trunk, allowing it to release (OS 718-1). Relay F releases FA-- and FB-- in

the trunk link circuit. This transfers the calling and called lines to the intraoffice trunk (FS-3, SD-26032). The trunk SL (supervisory) relay that was operated from ground in the marker, through the LV- and F relays, now provides the 10-ohm holding ground for both originating and terminating connections (OS 741-1). Relay SL is slow in releasing in order to hold between the release of relay F and the operation of relay S (supervisory). Relay S operates over the calling line loop (OS 741-1). It re-establishes an operating path for relay SL if the calling customer has not abandoned the call.

11. Marker Release

11.01 The release of relay FA-- removes the battery supplied to relay DCT through the SL (sleeve) relay winding (FS-46, 47, SD-26002). Relay DCT releases, and operates the DIS1 and DIS2 (disconnect) relays (FS-49, 50, SD-26002). The DIS1 relay releases the LLC1 relay which in turn releases the LLC2 and LLC3 relays. The operation of the DIS1 and DIS2 and the release of the LLC1, LLC2, and LLC3 relays will start the functions necessary to release the marker and associated circuits. After the marker has released it will appear idle so as to be available for assistance to other calls.

12. Originating Register and Originating Register Marker Connector Release

12.01 Relays DIS1 and DIS2 operate relay MRL in the originating register (FS-51, SD-26002, FS-1, SD-26023, FS-4, SD-26024 and FS-5, SD-26040). Relay MRL removes operating battery from the RS- relay in the originating register marker connector register part and the MS- relay in the preference control circuit thereby releasing the connector (FS-1, SD-26024, FS-2, SD-26029 and FS-5, SD-26040). Relay MRL also causes the register control relays to return to normal, thereby making the register available for a new usage.

13. Ringing the Called Customer (OS 725-1)

13.01 The particular ringing code to be used was set up during the terminating connection. The release of relay FB-- applies this ringing code to the called line. A portion of the ringing current is applied through the T and R capacitors to the calling line as an audible signal that ringing is in progress. When the called customer answers, the increased current flow resulting from the closed switchhook contacts causes relay RT to operate and release relay RC. Relay RC removes the ringing current from the line and releases relay RT. The release of relay RC connects talking battery to the called line through relay CS (called party supervisory), which operates (FS-1, SD-26060).

13.02 Relay CS causes the operation of the CH (charge) relay. Assuming that this is a flat rate trunk the CH relay has no charge function but serves to indicate that the call is complete to the called subscriber and as a result enables the timed disconnect feature to function.

13.03 Relay CH remains locked until relays S, CS, and SL release at the end of the call. Relay CH supplies an additional holding ground on the terminating or call-forward connection.

14. Disconnect at the End of the Call

Called Customer Disconnects First

14.01 When the called customer disconnects, relay CS releases. With relay CS released and relay CH operated, 48-volt battery is applied across the RL (release) heater element. Relay RL operates after a minimum of 13 seconds. This timed release feature prevents a calling customer from holding the called line out of service indefinitely.

14.02 The operation of the RL thermal relay reoperates the RC relay. This will release relay S1 which opens the holding circuit to both connecting paths. The calling and supervisory relay S will release when its circuit is opened by the release of the calling end connecting path and this will permit relay CH to release and restore the circuit to its normal idle condition.

Calling Customer Disconnects First

14.03 When the calling customer disconnects, relay S releases relay S1. Relay S1 releases the connection to the calling line by removing the holding ground. The connection to the called line, however, is held by ground through the CH relay contacts. If this connection were allowed to release, the release of the called line hold magnet would permit relay L- to operate. This would start a false seizure of an originating register.

14.04 The release of relay S1 applies ground to the RL heater element. Relay RL operates after a minimum of 13 seconds. This reoperates relay RC, thereby removing holding ground from the called line. The terminating connection releases and the trunk restores to normal.

14.05 If the called customer disconnects before the RC relay operates from the timed release feature, relay CS releases. This releases relay CH, thereby releasing the terminating connection and restoring the trunk to normal.

14.06 If the trunk is selected by a marker while being held by the called customer, the marker operates the trunk F relay. Relay F operates relay FB-- in the trunk link circuit, thereby opening the tip, ring, and sleeve leads. This releases the CS and CH relays, removing the called end holding ground. The trunk is now disconnected from the called line so that it is available to serve the new call.



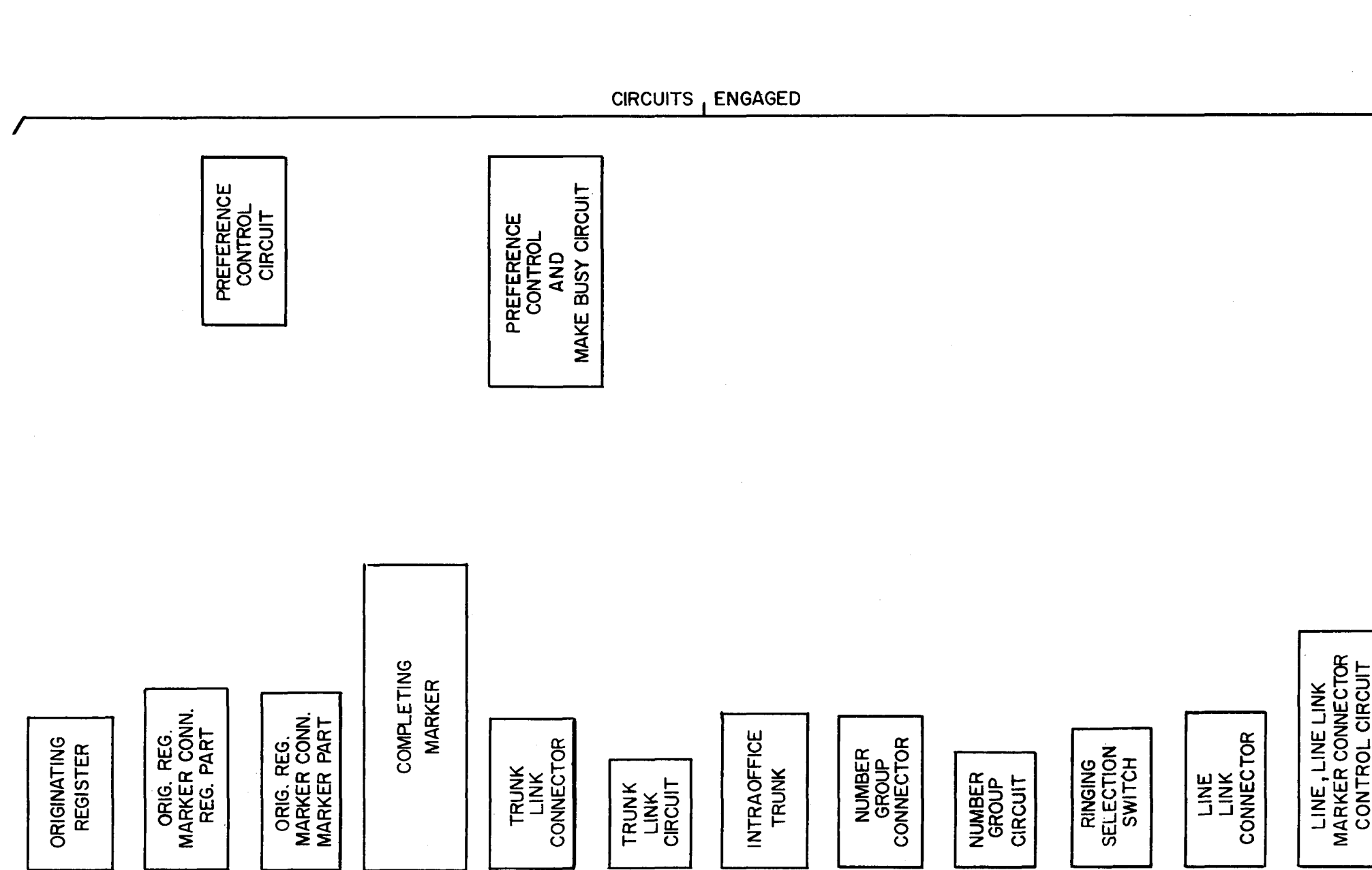


FIG. 1— PROGRESS DIAGRAM INTRAOFFICE CALL

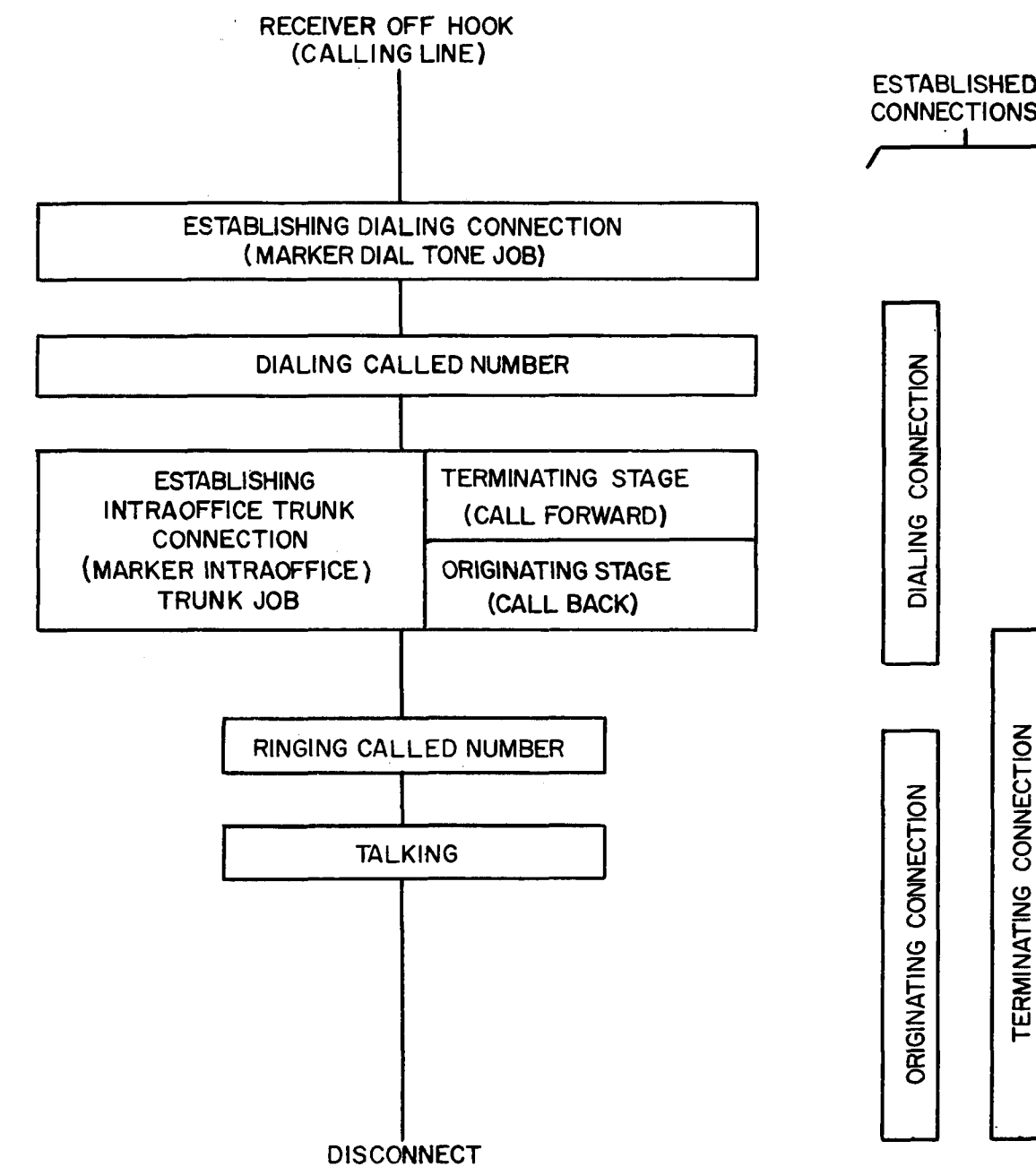


FIG. 1

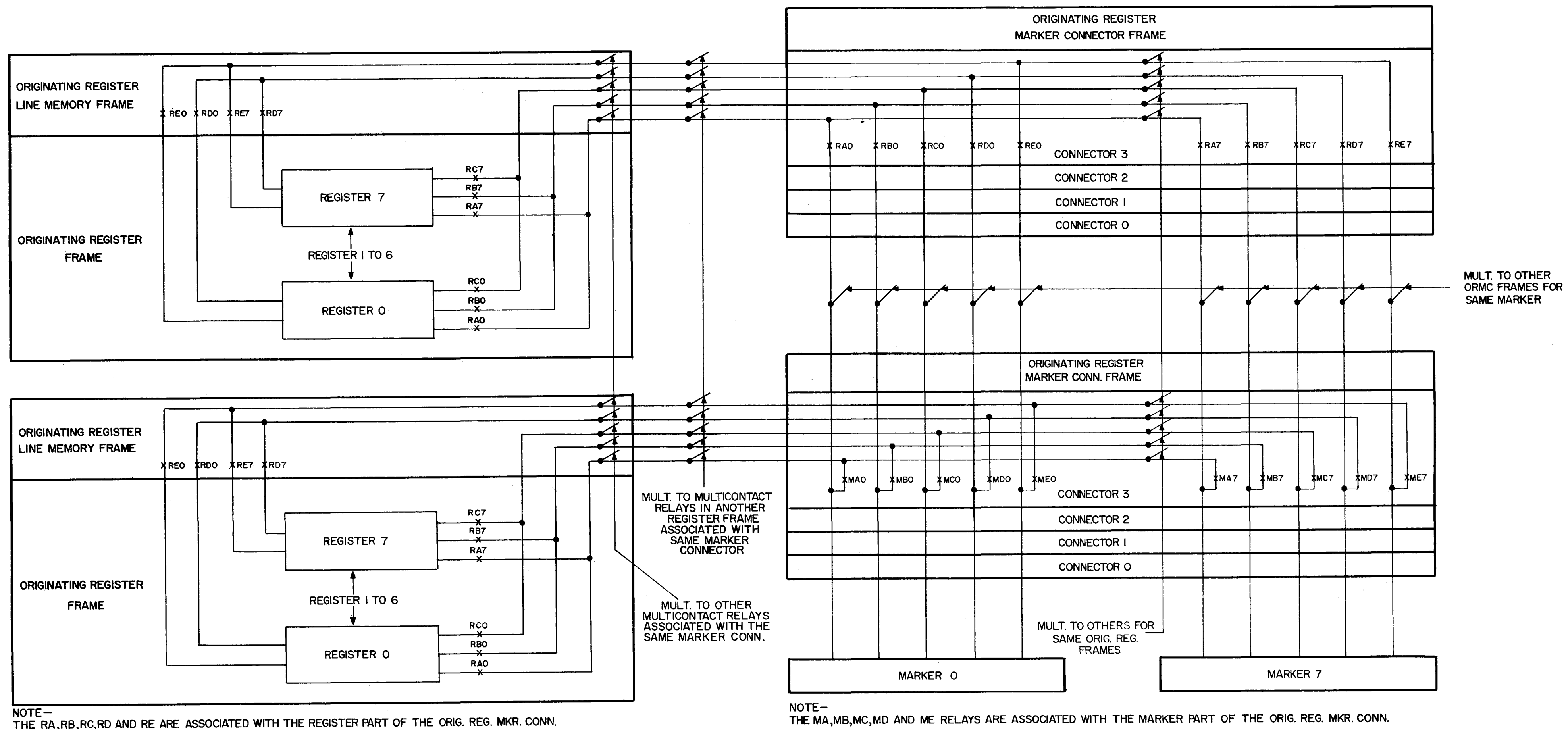


FIG. 2—TYPICAL MULTIPLE ARRANGEMENT OF THE ORIGINATING REGISTER FRAMES AND THE ORIGINATING REGISTER MARKER CONNECTOR FRAMES.

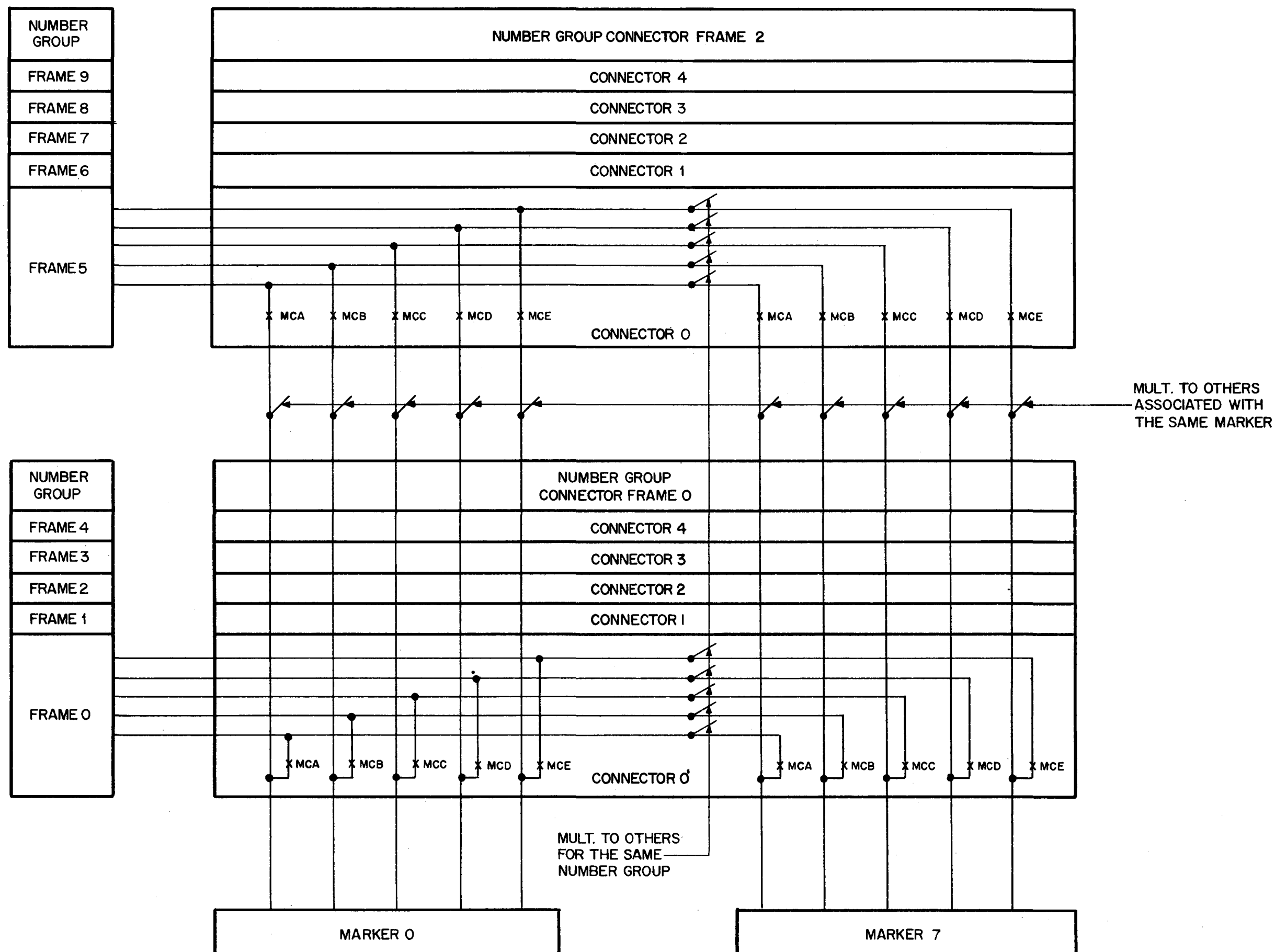


FIG. 3—TYPICAL MULTIPLE ARRANGEMENT OF THE NUMBER GROUP CONNECTOR FRAMES

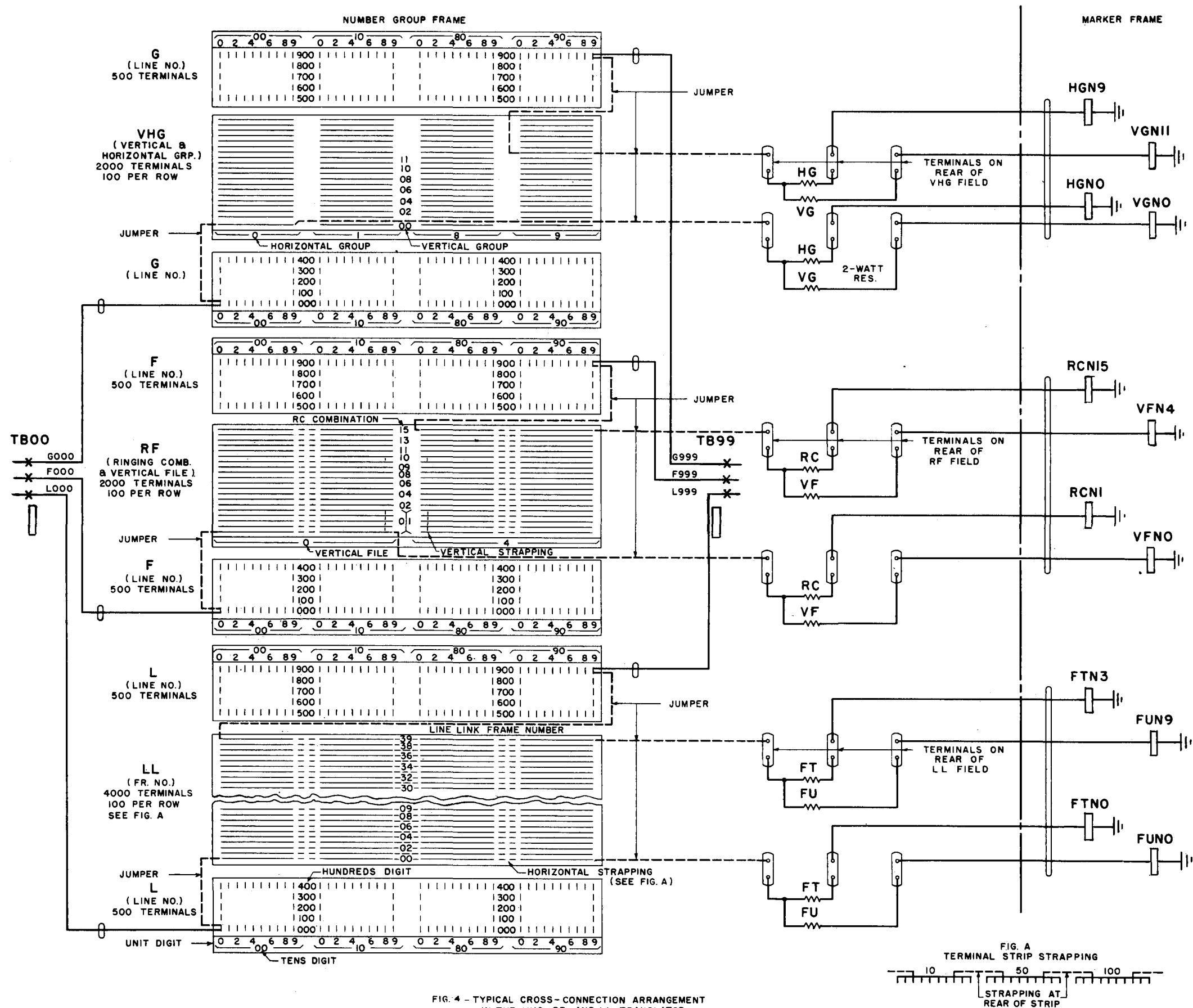


FIG. 4 - TYPICAL CROSS-CONNECTION ARRANGEMENT IN THE VH, RF, AND LL TRANSLATOR FIELDS FOR 40 LINE LINK FRAMES

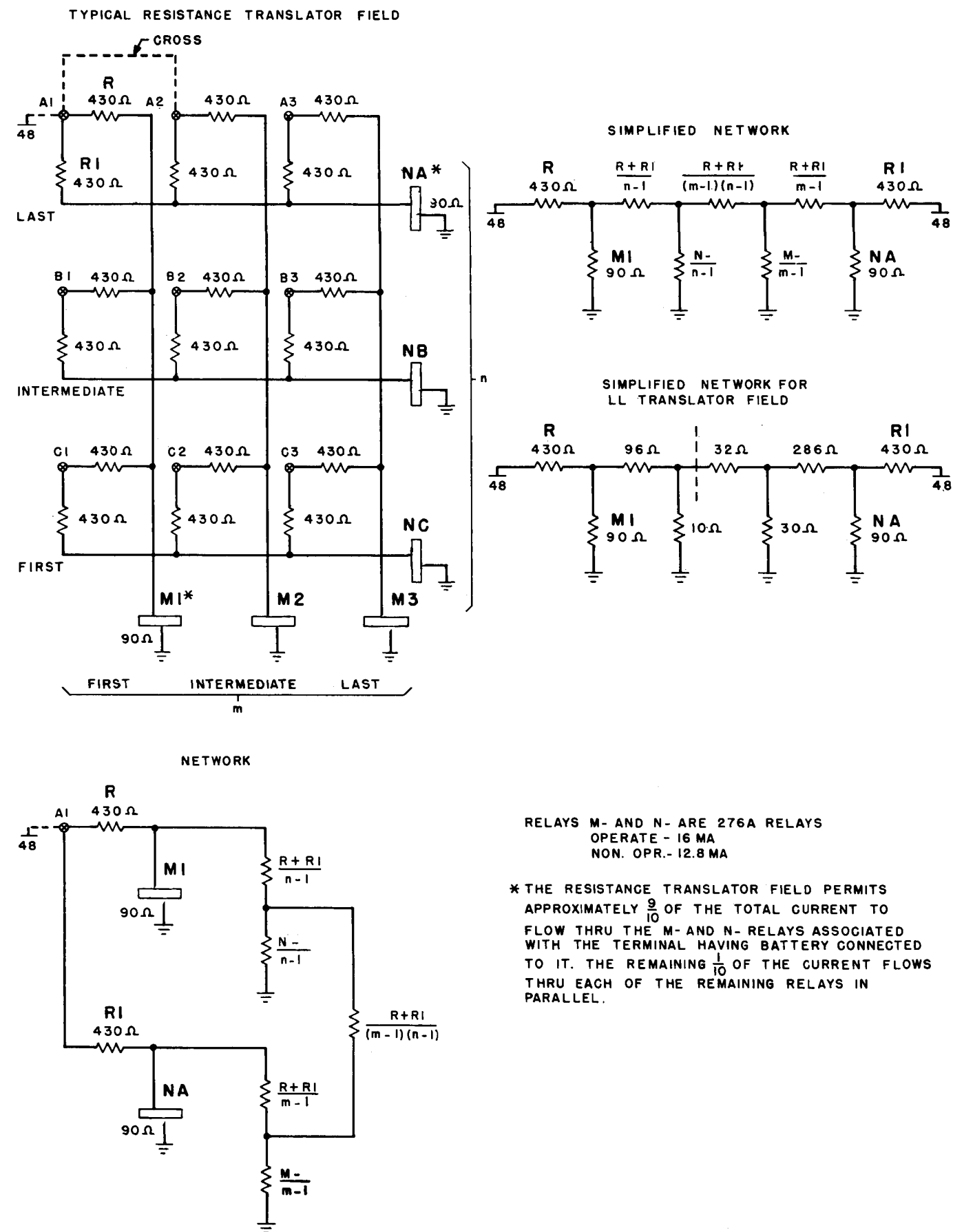


FIG. 5 - THEORY OF NUMBER GROUP TRANSLATOR NETWORK OPERATION

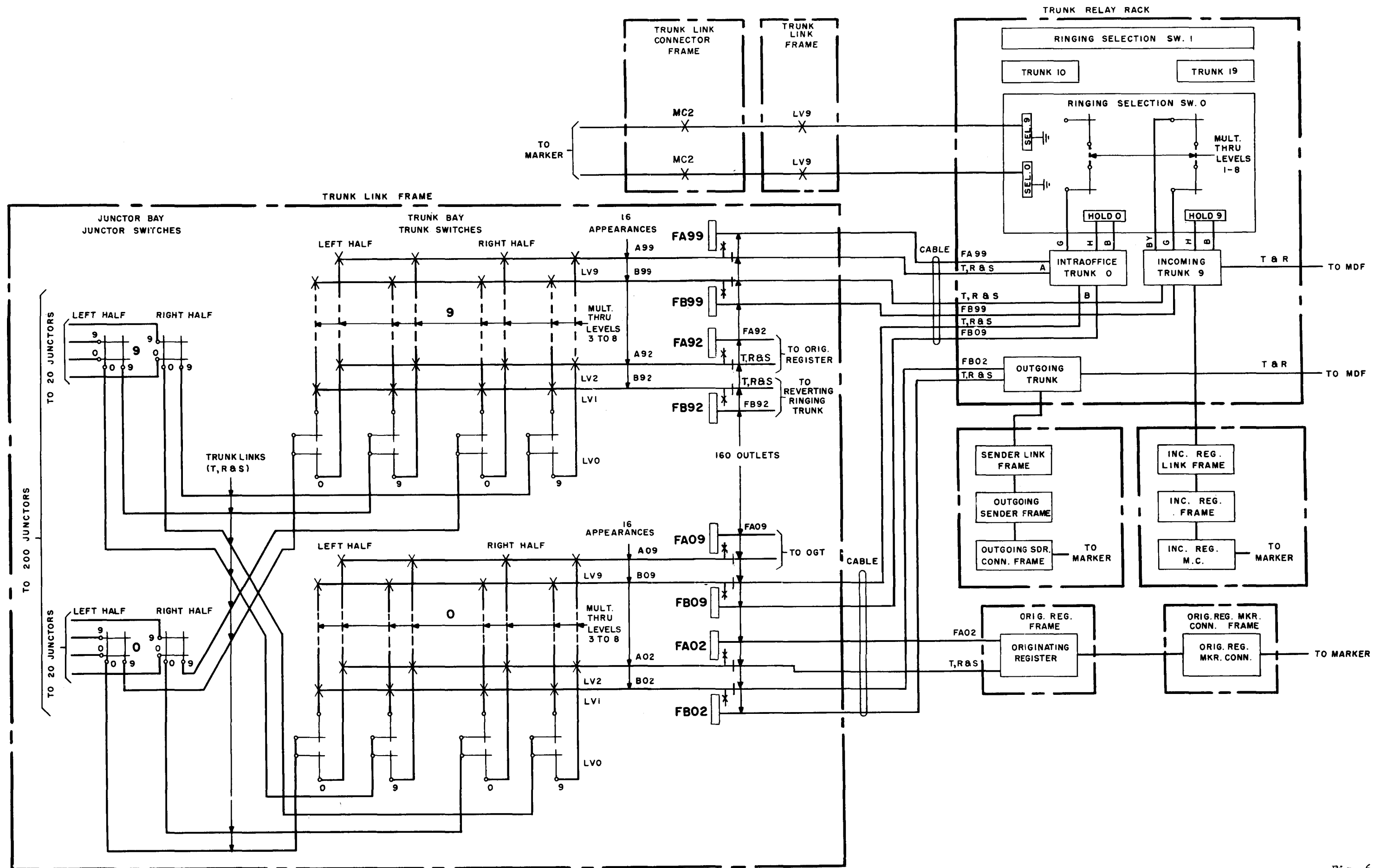


FIG. 6-TYPICAL CONNECTING ARRANGEMENT OF TRUNKS AND REGISTERS TO THE TRUNK LINK FRAME.

SECTION NO. 6

SUBSCRIBER OUTGOING CALLS USING SENDERS



SUBSCRIBER OUTGOING CALLS USING SENDERS

NO. 5 CROSSBAR OFFICES

CONTENTS	PAGE
A. INTRODUCTION	2
B. ESTABLISHING THE OUTGOING TRUNK CONNECTIONS	2
1. General	2
2. Translating the Called Office Code	3
3. Route Relay Operation	3
4. Selecting the Outgoing Sender	8
5. Trunk Link Frame and Line Link Frame Seizure	10
6. Connecting the Marker to the Sender and Sender to the Trunk	11
7. Transferring Information to the Outgoing Sender	13
8. Check of the Information in the Sender -- Non-AMA Call	16
9. Check of the Information in the Sender -- AMA Call	19
10. Building the Channel	22
11. Advance Signal and Linkage Check	23
12. Marker Disconnect and Trunk Test	24
13. Outputting the Digits	25

A. INTRODUCTION

1.01 This text is one of a group which describes the detailed circuit operation of the various types of calls handled by the No. 5 crossbar system with wire spring relays.

1.02 When a subscriber in a No. 5 crossbar office dials a central office code of some other central office, the completing marker must pick a trunk to that office and select a sender which will pulse the telephone number over the trunk. Of course it performs all the other necessary functions required for setting up a connection. This section of the text describes the marker job of establishing a subscriber outgoing trunk connection.

1.03 Before this can occur, certain things must have passed. A dial tone connection has been established, the subscriber has dialed and pre-translation of the dialed central office code has occurred. These three functions are described in Sections 2, 3 and 4 of this text, in that order.

1.04 The subscriber outgoing call begins when an originating register seizes a completing marker after the subscriber has completed dialing. If the student looks at Fig. 40 of Section 1 of this text - General Description - he will see a block diagram of the outgoing call. The originating register passes the dialed number and line location of the dialing subscriber to the completing marker. The marker examines the called central office code, operates a route relay, selects a trunk to the called office, picks a sender, passes information to the sender, establishes the channel, makes the necessary checks and disconnects. The sender pulses the required digits over the trunk and then disconnects itself. What we have left is the calling subscriber connected to the trunk through a channel. A diagram of this talking connection appears as Fig. 35 on Page 24 in the General Description (Section 1 of this text).

B. ESTABLISHING THE OUTGOING TRUNK CONNECTION

1. General

1.01 After the subscriber has completed dialing, the originating register puts out a marker start signal into its originating register marker connector. The seizure of the marker and the operation of the marker connector has been described in Section 5 of this text under the title - Intraoffice Call. The marker seizure, passage of the dialed digits and subscriber's line location is the same in the outgoing call as for the intraoffice call. OS 701-2 shows the circuit for marker seizure.

1.02 When the originating register is connected to the completing marker, it passes information to it. The marker examines the information so that it can determine what it is to do. Before it can start selecting a trunk, it must know the route. Before it can determine the route, it must examine the called office code. It considers the calling subscribers class of service when operating a route relay. The operated route relay gives the marker the directing information for this call. The route relay tells the marker where the outgoing trunks are located, what kind of sender is needed, how many digits must be pulsed, etc.

1.03 Much of the processes and functions in an outgoing call are similar to intraoffice calls. Seizing the trunk link frame, selecting the outgoing trunk, building the channel, etc. won't be repeated in this discussion. The student is encouraged to review these operations in Section 5 - Intraoffice Call.

2. Translating the Called Office Code

2.01 When the originating register connected to the completing marker, it passed the dialed digits to the marker. On sheet 1 of OS 715-1, we see how the A, B and C digits are sent to the marker. The marker also receives a local translator signal (LT relay operates) and an originating register call signal (OR relay operates). The marker examines the called office code and grounds a code point which is numbered to represent the dialed office code.

2.02 The operation of the translator circuits is the same for an intraoffice call. This process is described in Section 5 of this text under the heading Intraoffice Call.

2.03 Several examples of actual code points are shown on OS 715-1. Some of these examples are the code points of the central offices represented on the marker cross connection sketches. For instance, on sheet 1 of OS 716-1 we have some central offices represented as being in the local area and others in a distant area reached through tandem. The central office names appear as code points on both the code point grounding and marker cross connection sketches.

3. Route Relay Operation

3.01 After the marker has translated the A, B and C digits (which are the called central office code) and after it has grounded the associated code point for this office, it is ready to operate the route relay.

3.02 In order to operate the proper route relay and route series relay, the marker considers the calling subscribers class of service. When the originating register is connected to the completing marker, it passes the class of service information of the calling subscriber. On OS 714-1 we can see this operation. It is the same as for an intraoffice call. The marker receives and stores the calling subscriber's class of service and uses the contacts of these relays to ground two terminals which represent the subscriber's class of service. These punchings are cross-connected to screening relays (S-) as shown on sheet 1 of OS 714-1. Each class of service has two screening relays assigned to it but some classes of service share a common relay.

3.03 In that group of terminals under the heading - SORT 1 - each class of service punching is connected to an individual SW- punching for a screening relay. However, in the circuit under SORT 2, some classes of service share an S- relay and some have an individual relay. The reason for this arrangement is simply that some classes of service not only use the same group of trunks to complete an outgoing route, but also receive the same charge treatment. That is, the route series relay (NCNC or MBS- for instance) is the same. It makes no difference whether our subscriber is a private branch exchange flat rate (PBXF), individual flat rate (IF) or 2-party flat rate (2F).

They all receive the same routing and charge treatment for the various outgoing calls. By using the arrangement under SORT 2, we cut down considerably on our marker cross connections.

3.04 On sheet 2 of OS 714-1, under SORT 2, SWC-0 (PBXF), SWC-1 (IF) and SWC-2 (2F) are all connected to SW28. The contacts of relay S28 will provide the screening paths for these three classes of service for outgoing routes. This arrangement is copied for other classes of service which also get the same routing and charging treatment. If a class of service receives different treatment than the others, it is assigned its own screening relay in SORT 2. For example, look at SWC-3 terminal which represents class of service 03 in Podunk 5 - 4 party flat (4F). Since this class receives a route or charge treatment different than PBXF, IF and 2F, it has its own screening relay. This arrangement is carried on for other classes - coin, for instance.

3.05 On sheet 3 of OS 714-1, the marker cross-connection form, this arrangement of grouping classes of service to one S- relay is shown on the lower portion. Screening relay S28 is depicted as serving the first three classes of service columns. These are, of course, PBXF, 2F and IF.

3.06 On OS 716-1 sheet 3, we have the marker cross connections for typical outgoing routes. The code points shown are those represented on sheet 1, the block diagram. The screening relays (S28, S29, etc.) are the same ones that we saw under SORT 2 on OS 714-1, sheet 1.

3.07 Let's assume our subscriber making this call is a IF (individual flat rate) in Podunk 5. His class of service number is 01 and on OS 714-1, sheet 1, we see that his associated SWC-1 punching is connected to SW28. This means, of course, his screening relay is S28. If our subscriber has dialed a telephone in the Olympic 3 office, then the 653 code point has been grounded by the marker. This C653 terminal, which appears on sheet 3 of OS 716-1, is connected to SC12 which in turn is connected to USCO for the second group of screening relays (SORT 2).

3.08 If we trace the path of the ground, which the marker placed on the C653 code point we find it connected to SC12. This screening connection terminal is the first one associated with the second set of service relays. SCO to 11 terminals served the screening relays in SORT 1 and SC12 to 23 serve the screening relays in SORT 2. Since our subscriber has individual flat rate service (IF), S28 relay is operated and closes a path through its contacts to its S0 terminal and to grouping point SGL3. This in turn connects to route relay 30, the Olympic 3 - noncoin route relay, in series with NCNC relay. Our subscriber is allowed this call free. The trunk used for flat rate traffic from PO 6 and PO 6 to OL 3 does not require any class or charge signals from the marker. On this sketch, we can see that the flat rate subscribers are screened to the route relay 30. If our call is made by a coin or message rate subscriber, we operate different route relays. The two coin subscriber classes use route relay 34 and the message rate subscribers use route relay 35. The route series relay in series with route relay 34 is NCCN. This relay stands for noncharge - coin. Actually this is a charge call, but the trunk is designed to charge on all calls so that the marker needn't set a charge signal in the trunk. The route series relay used for message rate classes is MBS1. This is an AMA charge relay. It causes the marker to perform the necessary operations for automatic charging of the call.

3.09 For calls to the Olympic 3 office, the screening relay precedes the route relay. This arrangement is like the one we used on intraoffice screening. However, for the rest of the outgoing routes shown on sheet 3, the route relays precede the screening relays. Fig. 1 is a simple diagram for comparing the two arrangements of screening. If we intend to steer our subscribers over different routes, we place the screening relay before the route relay. When all subscribers use the same route but get different charging treatment, then the screening relay follows the route relay.

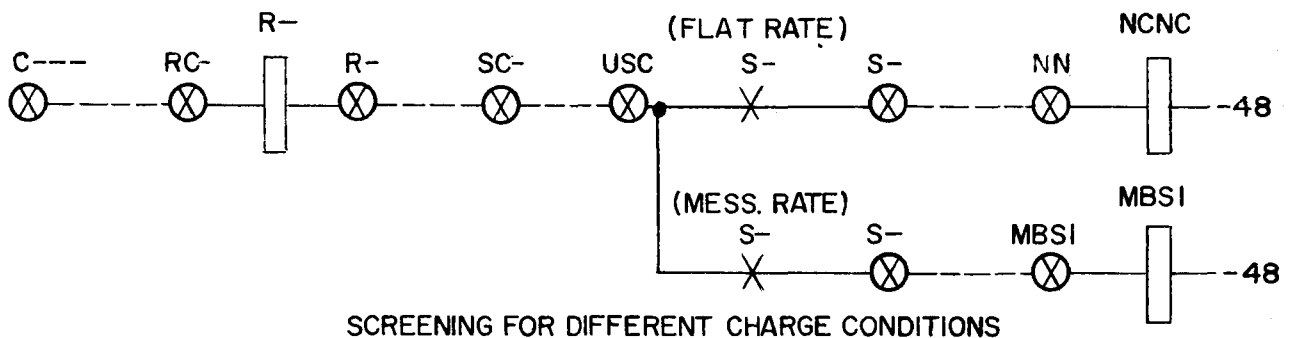
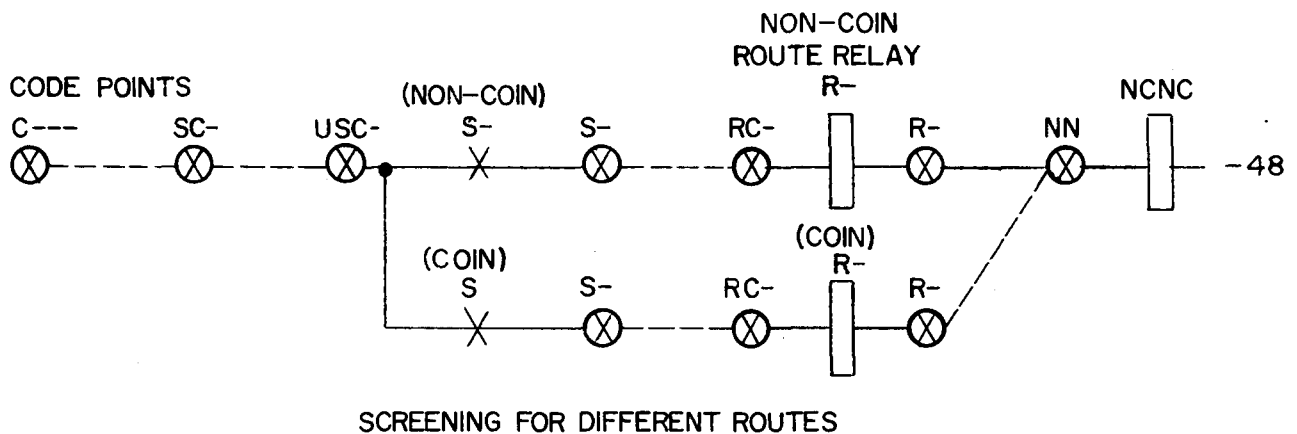


FIG. 1 - SCREENING METHODS

3.10 If we take a look at sheet 1 of OS 716-1 we see that there are two groups of trunks from Podunk 5 and 6 to Olympic 3. One group serves noncoin subscribers in either PO 5 or PO 6 and the other serves coin subscribers.

We have chosen this example of separate groups of trunks for coin and noncoin service to show the student this method of trunking. This trunking plan is used where the coin traffic to an office is enough to warrant a separate group of trunks. Actually we have used three route relays for these trunk groups. Route relay 34 controls the selection of the coin trunks and both route relays 30 and 35 control the selection of the noncoin group. When route relay 30 operates, NCNC operates in series with it and the call is free. This is for flat rate subscribers. When route relay 35 operates, MBS1 operates in series with it. This is a charge call for message rate subscribers. If we consider a call to a Mission 3 subscriber made by a coin telephone subscriber in Podunk 5, we have a different arrangement of trunking. On OS 716-1, sheet 1, we can see that there is only one group of trunks from PO 5 and PO 6 to MI 3. This group of trunks serves coin and noncoin traffic. Our coin subscribers in PO 5 have class of service number 07. Screening relay 31 in SORT 2 is assigned to them. On sheet 3 of OS 716-1 we can see how this works. Code point C643 is grounded by the translator circuit when our subscriber calls Mission 3. S31 screening relay is operated. We have a circuit from C643 through route relay R31, SC13 to USC1 cross connection, operated S31 to winding of DRL. This relay (diverted route No. 1) has a high resistance. It operates but limits the current through R31 so that it won't operate. On the lower right of the sheet we can see how contacts of DRL operate R13, the coin junctor route relay, in series with NCNC. Because coin junctors only handle coin calls, and because the trunk is designed so that every call is a charge, we don't have to set a coin or charge signal in the trunk. On sheet 3 we have examples of both these methods. Calls to Olympic 3 are screened ahead of the route relay, calls to the other central offices are screened after the route relay.

3.11 Several of the various route series relays, which can be used are shown on sheet 3. For instance if we consider several calls by the various classes of service we run into different route series relays. If a flat rate subscriber in PO 5 (S28 screening relay) calls Mission 3, the route series relay is NCNC. This is a free call for him. However, if a message rate subscriber calls Mission 3, he is routed to MBS1 (message billing index 1) through operated S30 relay. A coin subscriber is routed to DRL (diverted route No. 1) through his operated S31 screening relay. The operation of the coin call is somewhat different for this example. The operation of coin junctors is discussed in A874.201.11. If we continue to examine the screening of calls to Mission 3 made by subscribers in PO 6 office we get some slightly different results. A flat rate subscriber (S36) is routed to MBS2. This call is a charge call for him. In other words, flat rate subscribers in PO 5 can call Mission 3 for nothing, while flat rate subscribers in PO 6 are charged. On sheet 1 of OS 716-1 it can be reasoned why. The Mission 3 central office is located nearer those subscribers in our marker group who are in the Podunk 5 exchange area. If we look at the relationship between Baring 2 and PO 5, 6, we see just the opposite is true. And upon examining the screening on sheet 3, we see that flat rate subscribers in PO 5 (S28) are charged (MBS2 route series relay) while flat rate subscribers in PO 6 (S36) are not charged (NCNC).

3.12 Another screening condition is shown where a 4-party subscriber in PO 6 dials the Mission 3 code. If we trace this screening path from the C643 code point through operated S37 for the 4F PO 6 customer, we end up at the winding of DRO relay. If we take a call to Baring 2 by a 4-party customer in PO 5, S29 relay also directs the routing to the winding of DRO. In either

of these examples the call which the subscriber has attempted to dial is restricted from his use because it is a multiunit charge call. Because the 4-party subscribers can't be charged by the AMA equipment, we divert his call from the original route. In either of these cases, the route relays can't operate because the high resistance of the DRO limits the current flow. DRO does operate, however and causes another route relay to operate which will direct the call to an operator.

3.13 If subscribers should dial either Murdock 6 or Murdock 7 telephone numbers they use a common group of trunks. We see on sheet 3 that both of these code points are connected to winding of route relay 33. This is also shown on sheet 1 - the block diagram. There is one group of trunks from PO 5, 6 to MU 6, 7.

3.14 On sheet 3 again, we can trace the results of the screening of calls to MU 6, 7. PBXF, IF and 2F subscribers in PO 5 (screening relay S28) are routed to MBS9 route series relay. Also the message rate subscribers using S30 relay are routed to MBS9. In fact the PBXF, IF, 2F, PBXMR and IMR subscribers of PO 6 are also routed to MBS9 relay. This is another of the automatic message accounting index relays. It is used for multiunit calls when a detailed record of the call is required. Coin and 4-party subscribers calling MI 3 are diverted. Coin reaches the operator through the DR2 (restricted route - coin) and 4-party reaches the operator through DRO (restricted route 4-party). In either case route relay 33 doesn't operate.

3.15 Four examples are shown on the block diagram on sheet 1, of offices which are reached through a tandem switching center. Woodlawn 3, Hubbard 2, Fairview 3 and Main 3 are some distance away. There are no direct trunks from PO 5, 6 to these offices. On sheet 3 we notice that the code points of the first three of these offices are connected to a grouping terminal CG2 (code grouping). This assignment is, of course, arbitrary. It is merely a convenient place for connecting those codes which must ultimately connect to the same point. Likewise we see the other side of route relay 25 is connected to a common grouping point, RG- (route relay grouping). These punchings are assigned and offer a convenient place for grouping the connections from route relay windings when they must connect to a common point - SC15 in this example.

3.16 The various screening arrangements for calls to these three offices are similar to those we have talked about. However, we have one office left, Main 3. This central office a code is intercepted at some distant point. It is a free call for those subscribers who could dial it when it was a working code but coin and 4-party customers are restricted from this route. The route series relay MBS0, is an AMA index. It is a noncharge condition.

3.17 The various examples of route relay arrangements on this sheet are typical. They will agree with the arrangements in working offices to the extent that our fictitious central offices, Podunk 5 and 6, are similar to that office. By studying the various arrangements on this and other route relay sheets in this series, the student can better understand the ones he may encounter in his own office. The assignments used on these sketches are, of course, arbitrary. They are written out on the route relay cross connection sheet on OS 714-1 so that the student can learn how this information is presented and so that the student has a handy record of the relay and terminal assignments used on this sketch.

4. Selecting the Outgoing Sender

4.01 General: After the completing marker has operated the route relay it can select a sender and trunk link frame. The selection and seizure of the trunk link frame and trunk is the same as for an intraoffice call. This process is explained in Section 5 - Intraoffice Call. Before the marker can select a trunk link frame, it must have seized an outgoing sender connector. The marker selects the proper kind of sender and attaches or connects it to the trunk through the outgoing sender link. This part will describe the method of selecting and seizing an outgoing sender.

4.02 On Fig. 40 of the General Description, which is in Section 1 of this text, the completing marker is now in position to do step 2 of the block diagram. The route relay indicates the sender type needed and then the marker seizes an outgoing sender connector.

4.03 All of the outgoing senders are arranged in groups according to type of pulsing. There can be maximum of ten senders in a sender group. A sender group is divided into two subgroups, A and B, having a maximum of five senders each. The two subgroups of an outsender group are assigned to different connectors on the same connector frame. This is done to avoid having all of the senders of a group inaccessible to the markers should an associated connector fail. The connectors are designated with the subgroup indication. There is a connector for subgroups A and another connector for subgroups B. Two outgoing sender connectors are required to serve an outgoing sender group. Subgroups of other outgoing sender groups are assigned to these same connectors, but all senders in the same group must be assigned to the same pair of connectors if there are more than two outgoing sender connectors. For calls requiring senders, the marker gives alternate preference to senders in subgroups A and B. However, if all senders are busy in the preferred subgroup, the marker chooses a sender in the other subgroup connector.

4.04 When more than ten outgoing senders of the same type are needed in a marker group, we can make two or more sender groups of this type. Each of these sender groups is associated with a different group of outgoing trunks. The cross connections on the route relay direct the marker to pick an outgoing trunk (TB-, TG-) which is located on the same switch as the outsender (OS-). When more than ten senders of one kind are needed, the two or more groups of these senders are considered as different kinds as far as the marker is concerned. This is necessarily so because senders in these groups would be located on different switches on the outsender link frame. The marker must pick an outgoing trunk and outsender which appear on the same frame. However, where more than twenty outgoing trunks of the same route are assigned to a trunk link frame, the trunks are subgrouped. The trunks in the subgroups are assigned equally to the two sender groups. In this case, the marker is provided with a two step allotter circuit which selects one of these two trunk subgroups. The selection of the subgroup of trunks identifies the sender group for this call.

4.05 Between the marker and the outgoing sender there are two channels, a common channel and an individual channel. The common channel (Fig. 2) connects all markers to a sender subgroup. It is established by the operation of the outgoing sender connector relays. The common channel extends the

registration (A to L digits) and route information (delete, code pattern, etc.) leads to the selected sender. After this information is transferred to the sender and checked, the marker releases this channel. Then it can be used by other markers connecting to other outgoing senders in the subgroup. Between each marker and each sender there is an individual channel. Fig. 3 shows this arrangement. A marker has five control leads which bridge on contacts of one S- relay for each sender. The other side of the S- relays are wired to their associated senders. On the sender side, the multiple is common to all S- relays for one sender, for all the completing markers. To sum up this point, we can say there is an S- relay for each sender, for each marker in the office. The control leads let the marker retain control of a sender after the common channel is released. The common and individual channel arrangement is used so that a marker ties up the whole sender subgroup (connector) for only a short time. The marker retains control over the sender until it finishes the outgoing call.

4.06 During outpulsing the senders are connected to the outgoing trunks. This is accomplished by having the trunks and the senders appear on crossbar switches of an outgoing sender link frame. The senders appear on horizontals of the switches and outgoing trunks appear on verticals. This provides a flexible means of connecting any trunk to any sender in the group which serves it. When outgoing trunks are not allotted, all the senders of one type have access to all the outgoing trunks which require senders of that type. When outgoing trunks are allotted, all of the outgoing senders in one group (maximum 10 per group) have access to one group of allotted trunks, and all of the outgoing senders of the same type in the other group have access to the other group of allotted trunks.

4.07 On OS 729-1 we have the circuit for operating an OSG- relay. The R- contacts shown, ground a punching OS-. These contacts represent those of any of the various route relays which are associated with the outgoing routes shown on OS 716-1, sheet 3. There is an OS- terminal for each route relay. It is numbered the same as its route relay and is cross-connected to the OSC- terminal which represents the kind of sender (dial pulse, multifrequency, etc.) which is required for pulsing on trunks in this route. Generally we can say that dial pulse senders are used to pulse to step-by-step offices, multifrequency senders to crossbar offices and panel call indicator to manual offices with "B" switchboards. The actual kind of pulsing depends on the central offices in each area.

4.08 The operated OSG- relay represents one group of a maximum of ten groups of senders OSG0 to 9. All the senders in a group are the same type, either MF, DP, PCl, etc. While we can have ten groups of senders, there are only five different types of senders which can be used. They are MF, DP, PCl, REV and IMG. There can be ten senders of a type in one group. Each group of senders is divided into two subgroups - A and B. If we have, for instance, three groups of outgoing senders, OSG0, OSG1 and OSG2, then we have six subgroups of senders. All the A subgroups are associated with connector 0 and all the B subgroups with connector 1. In this example there could be thirty senders in the office, fifteen in each connector.

4.09 The operated OSG- relay cuts through test leads from each sender subgroup to the marker. An idle sender in a subgroup grounds a lead common to the subgroup which indicates its idleness to the marker by operating STA for subgroup A or SLB if it is in subgroup B. If a connector is busy, it signals the

marker by operating GBA (group busy A) or GBB (group busy B) relays in the marker. The ground which operates a GBA or GBB relay in a marker, comes from an operated multicontact relay (MAL) in the connector. Of course if this relay is operated in a connector, it means that some other marker is working there. The marker attempts to select an idle connector which has one idle sender of the kind it needs.

4.10 If both connectors are idle (GBA and GBB relays not operated) and both connectors have idle senders of the kind it wants (SLA and SLB operated) then the marker uses its sequence circuit to select a connector. If either connector is busy the sequence circuit is ineffective in the selection process. For example on OS 729-1, if some other marker is working in connector 0, then it would have its associated MAL relay operated in this connector. This sends a ground to the other markers indicating a busy connector. This ground would operate the GBA relay in our marker. Because all senders in subgroup A are in this busy connector, the operated GBA contacts close a path around the sequence relay contacts in the B subgroup start lead. This allows our marker to seize subgroup B when the sequence circuit says take subgroup A.

4.11 Also we must consider the case when both connectors are idle, but only one of them has idle senders of the kind we want. Suppose on this call that connectors 0 and 1 are not engaged with another marker and connector 0 has no idle senders of the type we need. Neither GBA nor GBB would be operated in our marker. However, SLA would be normal and SLB operated. SLA being normal, opens the path for seizing connector 0. Operated SLB closes the path for seizing connector 1.

4.12 In both sender connector start leads we see normal contacts of the SP relay bridged by the SKA or SKB operated. If the marker runs into a trouble condition before seizing the outgoing sender, the SP (stop progress) operates to prevent its seizing the connector when it can't use it on the call. The SKA or SKB contacts bridge the SP normals so that if the marker runs into trouble after it has seized the connector, it doesn't lose it when the SP operates. In both start leads we have contacts of the FTCK relay. This prevents the marker from seizing a connector if there are no idle outgoing trunks of the route it desires.

4.13 Now that the marker has decided which of the two outsender connectors to seize, it puts out start lead battery which operates its MP- relay in the preference control circuit. The operated MP- relay sends a ground back to the marker operating the SKA (sender connector check) if group A is seized or SKB if group B is selected. The preference control circuit for each outsender connector is the same as the preference control circuit for the trunk link and line link connectors. The student can review this operation in Section 5 - Intraoffice Call. As soon as the SKA or SKB relay operates, the marker can seize a trunk link frame.

5. Trunk Link Frame and Line Link Frame Seizure

5.01 The marker can perform the process of trunk link frame selection as soon as the route relay operates. The TB- and TG- cross connections direct it to the trunks for the outgoing route. However, the marker must wait for an indication that it has seized an outsender connector before it can put out start battery to operate the MP- relay for the trunk link frame.

5.02 The marker has the calling subscriber's line location and uses the frame tens and units information to steer it to his line link frame. Yet it must wait for a signal that it has seized control of a trunk link frame before it can put out the start battery for the line link frame MP-relay. This path is closed by TFK2 relay. TFK2 operates where marker seizes the trunk link connector.

5.03 The marker is designed this way so that equipment is not needlessly tied up when a call can't be completed. For instance, suppose there were no idle senders when our marker attempted to do this SOG job. There would be no good in seizing an outgoing trunk to an office which we couldn't connect to for lack of a sender.

6. Connecting the Marker to the Sender and Sender to the Trunk

6.01 General: The outgoing sender connector has three parts. The preference control circuit (MP, EP, relays) the marker part of the connector (MA1, MA2, etc.) and the sender part (SA1, SA2, etc.). The preference control circuit allows one marker at a time to work the connector. The marker part of the connector is a group of multicontact relays (one set for each marker) which place the marker on the common connector multiple. The sender part is also a group of multicontact relays (one set for each sender) which place the sender on the same common multiple. When these two sets of relays are operated, many leads are closed from the marker to the sender.

6.02 In the marker part of the outsender connector, we have the OSGAO to 4 in connector 0, and OSGB0 to 4 in connector 1. These relays are assigned to outsender groups by the A- to OSGAO to 4 cross connection. For instance if OSG0 relay in the marker represents the multifrequency group, then the multifrequency senders in connector 0 (subgroup A) would be assigned to OSGAO relay. OSGAO terminal would be cross-connected to the AO terminal. There is an OSGAO relay in connector 0 for each completing marker. Generally, we can say that in outgoing sender connector 0 there is one OSGA- relay for each sender group, for each marker. If we have in our office three groups of senders and four completing markers, our OSGA- relays would total fifteen. Of course, in connector 1 we would have fifteen OSGB- relays also. We can have a maximum of five outsender groups in an outsender connector but we are limited to only fifteen senders in a connector. Whatever arrangement of senders in a connector we have is limited by these factors.

6.03 The OSGA- or OSGB- relay which is operated, is common to our marker and to our sender subgroup. It operates the multicontact relays in the connector which are associated with our marker. This operation connects the marker to the common multiple between all completing markers and this one outsender connector. OS 730-1 shows the operation of the connector relays MA1, MA2, MB1, MB2, MC1, MC2. There is a set of these relays for each completing marker in each connector. Also on this drawing we can see how the marker selects one sender of a subgroup. If our marker has seized connector 1 we can trace the circuit for operating a particular OS- relay. We have said there can be five outsenders in a subgroup. The marker has five OS relays for picking a sender in a subgroup. The operated OSGB- relay for the sender subgroup, for our marker, closes through leads from the windings of the OSO to 4 relays to

the five senders in a subgroup. If any sender in the subgroup is idle, it grounds its lead which operates its representative OS- relay in the marker circuit. The marker uses its sequence circuit to select an operated OS- when two or more are operated. This selection circuit works on the same principle as the trunk selection circuit. The sequence circuit rotates the preference. The OSE (outsender selection end) relay operates when any one OS- operates. It acts as a gate - it opens the selecting leads from the marker to the connector as soon as one OS- operates. Any operated OS- relay operates OSEL on OS 730-1. OSEL operates OSK (outsender check) which in turn operates FKA. Now we have a path for operating the S- relay for our selected sender. There is an S- relay for each sender, for each completing marker. They are numbered S0 to S14 and correspond to the S0 to S14 punches on the trouble card. The operated S- relay closes the individual channel between our marker and the selected sender. The marker uses this channel for control leads. It will keep this connection closed until it disconnects at the end of the subscriber outgoing job. The operated S- relay operates associated connector relays which put the selected sender on the connector common multiple. These are the SA1, SA2, SB1, SB2, SC1, SC2 multicontact relays. Now there are a lot of leads cut through from the marker to the sender. The marker uses these leads to pass to the sender all the information required for the call. The S- relay also operates the ON1 on OS 731-1 and the ON1 operates the SB. The operated SB makes this sender appear busy to all markers from now on until it releases when its job is done.

6.04 The marker must now connect the selected sender to the selected outgoing trunk. Its particular problem is to close the proper crosspoints on one of the outsender link switches so that the trunk and sender will be connected. Senders are connected to horizontals of outsender link frame switches and trunks are connected to the verticals. The switches have twenty verticals. All the verticals of a particular switch are associated with a trunk link frame. One or more switches, as required, are assigned to a trunk link frame. For instance, if in a particular office, there are sixty trunks on each trunk link frame which require pulsing, then three switches would nearly accommodate them. Of course in practice we must allow for growth. However, for the purposes of instruction we can assume each trunk link frame would have three outsender link switches. The first three switches on OSLO would be assigned to trunk link frame 00, the next three switches would be assigned to trunk link frame 01 and so on. See Fig. 4 for a diagram of this arrangement. The senders are assigned to the horizontals of the switches. All the senders of a type are grouped on one switch. Therefore all those trunks of a trunk link frame which require multifrequency pulsing must be assigned the verticals of only one of the switches for that trunk link frame and they must be assigned to that particular switch which has the multifrequency senders on its horizontals. Now we can say about a particular outsender link switch that it belongs to a certain trunk link frame, and is used for a certain kind of pulsing.

6.05 This arrangement of trunks and senders simplifies our markers problem of finding the proper select and hold magnets for the sender and trunk it has picked. On OS 731-1, sheet 1, we see an arrangement where each trunk link frame is assigned two outsender link switches. Switches 0 and 1 are MF and DP and are associated with trunks on TL00. Switches 2 and 3 are MF and DP for TL01 and so on. The two verticals shown (zero left and nine right) represent the twenty verticals on the switches. Two levels are shown which represent the

ten levels of the switch. The capacity of switch 0 is ten multifrequency senders and twenty trunks requiring multifrequency pulsing. All twenty trunks are assigned to TL00. We can see that the paths for operating SSO to 4 (select magnets) are through contacts of OSO to 4 and SSA (sender subgroup A) relays. The paths for SS5 to 9 are through OSO to 4 and SSB (sender subgroup B). This implies that those senders on levels zero to four are in subgroup A and senders on levels five to nine are in subgroup B. Those senders in any A subgroup which are selected by OSO relay in a marker will occupy level zero of the switches on which they appear. Similarly, senders selected by OS1 will be on level one and so on. In sender subgroup B, those senders selected by OSO will occupy level five, those senders selected by OS1 will be on level six and so on. No matter what sender the marker chooses in either subgroup, the operating path for the select magnet for a sender is through operated contacts of a trunk link connector relay. Because our marker has already seized the trunk link frame, and has the connector relays operated, it uses this means to direct it to those switches on the outsender link frames which are associated with the trunk link frame it has selected. The operation of one SSO to 9 select magnet operates SHK which in turn operates SHKA. When a marker operates the select magnet for a sender on a particular switch, it also operates the select magnets on corresponding levels on all other switches associated with the trunk link frame with which it is working. For example, if in a particular office each trunk link frame has three outsender link switches associated with it, and a marker has selected a sender which appears on level zero of one of these switches, it also operates the two other magnets for levels zero on the two other switches. However, only one trunk on all the sixty verticals of these three switches can have its F relay operated at one time. Therefore, the two extra select magnets which operate do no work nor cause any trouble.

6.06 Now the marker must operate the hold magnet for the particular vertical of the particular switch that has our trunk on it. The hold magnets are grounded on one side. On OS 731-1, sheet 1, each hold magnet is connected by one wire of a cross connection to a lead which carries its winding to operated contacts of an F relay in the trunk. Of all the trunks on all the outsender link switches associated with the trunk link frame used on this call, only our trunk has its F relay operated. This is naturally so because our marker has seized this trunk link frame and has selected this particular trunk. This carries the operating circuit to the trunk link connector and thence into the marker. The marker has two methods of operating the hold magnets. They are the same as the methods described for operating hold magnets on trunk link and line link frames. This operation has been described in Section 2 - Dial Tone Call. After the hold magnet on the outsender link is operated, the ON relay on OS 731-1, sheet 2 operates. Its path is through the operated crosspoints on the HM lead, through the operated F relay of the selected trunk, through the operated contacts of the select magnet associated with the sender, the operated contacts of M relay in the trunk link connector to the marker circuit and ground through winding of SLK. Now the selected outgoing sender is connected to the outgoing trunk through the operated crosspoints.

7. Transferring Information to the Outgoing Sender

7.01 When the outsender connector relays operated, they closed through leads from our marker to the sender. The marker passes information over these leads, checks that it is locked up in the sender and then releases the common channel between itself and the sender.

7.02 The marker transfers the following information to the outgoing sender:

- (a) Office code and numerals of the called line.
- (b) Number of digits to be outpulsed.
- (c) Arbitrary digit to be prefixed in outpulsing.
- (d) Speed and pulsing condition required.
- (e) Type of trunk test required.

7.03 On OS 719-1, sheet 2, we see the gating relays in the marker. These relays were operated when the marker started to select an outsender. In operating, these relays allow the grounds from the contacts of the digit register relays in the originating register to operate the digit register relays in the marker. This operation is shown on sheet 1. The AC, BC and CC relays in the marker have already played a part in this call when the code point was grounded. The marker digit register relays operate, two-out-of-five for each digit to correspond to the dialed digits which are stored in the originating register. On sheet 1, we can trace a ground in the originating register from the ON1 and MST1 relays operated through the last steering relay operated to the "7" lead of the digit register which is one higher than the last digit dialed. This single "7" is carried through the circuit from originating register to marker to outsender. It is used to indicate the last digit position. Table A shows the operation of the digit register relays including the extra "7" in the last plus one digit register. If the digits dialed happen to fill up the complement of the digit registers (eleven digit toll call) then the ground comes into the marker on the M7 lead and operates the ST7 relay.

TABLE A

Number of Digits Received by Marker	2/5 Digits in Registers	Single "7"
1	A	B7
3	A-C	D7
4	A-D	E7
5	A-E	F7
7 - Intraoffice (AMA Call) and Outgoing Call	A-G	H7
8 - Outgoing Call to Manual Office (With Party Letter)	A-H	J7
10 - Subscriber Dialed Toll Call	A-K	L7
11 - Subscriber Dialed Toll Call and Party Letter	A-L	ST7

7.04 When the digits are received by the marker and passed on to the outsender, the marker makes a check of the information. On FS 76 of SD-26002 (the completing marker) it operates two relays in series. The ORK1 and ORK2 (originating register check) operate through contact chains of the A to L relays. The contacts of the A to L relays, shown on this FS, belong to the A to L digit register relays in the marker shown on OS 719-1, sheet 1. There is one path for getting through the A relays, it is when two out of five of them

are operated. There are two paths for getting through the B relays. When two of them are operated or when only B7 is operated, we can go through. There are three paths for getting through all the others: (1) when two out of five are operated (2) where none are operated (3) when a single seven is operated. By using Table A, the student can trace the paths for various numbers of digits stored in these relays. We will see what purpose the ORK1 and ORK2 perform after we see how the other information is passed to the sender.

7.05 The marker has to tell the outsender how many digits to output. If our subscriber dials a telephone in a nearby central office, he will dial seven digits. The sender does not have to output the office code if we have direct trunks. On OS 716-1, sheet 1 which is the block diagram of our central office area, we can see that for a call to Baring 2 central office we have direct trunks. The marker would tell the sender to delete three digits. That is, output the D, E, F and G digits. However, if our call was to Murdock 7, we would have to send five digits. There is a common group of trunks serving both of these offices, therefore we would have to send the "six" or "seven" of MU 6 or MU 7 to direct the call to the proper central office. In this example, the marker would tell the sender to delete two digits. That is, output the C, D, E, F and G digits. For a third problem consider a call to Fairview 3 central office. We can see on the block diagram how this call is reached through the tandem switching center. We would have to send the entire office code out so that the tandem office could translate it for connecting to Fairview 3. In this case our marker would tell the sender to delete no digits. That is, output all of them A to G.

7.06 The delete information comes from a DL- punching of the route relay. Each route relay has one and it has the same number as the route relay. There are fifteen punchings in the marker which represent various delete conditions. They are numbered DLOS to DL6S, DLOP to DL6P and NDI. The DL- punching of a route relay is cross-connected to one of these punchings according to the marker cross connections for the office. The meanings of these punchings are explained in the D section of SD-26002-01 (completing marker). So that the student can understand this process, we will discuss the three examples in paragraph 7.05.

7.07 Our first call was to Baring 2. The route relay assigned to Baring 2 is R32. We want the sender to output only the D-G digits, which is to say - delete three digits. On sheet D8 of SD-26002-01, cross connection table Part 6, we can see that the DL3S punching represents the deletion of the A, B and C digits with no 11 prefix. This is what we want. So DL32 is cross-connected to DL3S. On FS64 of SD-26002-01 this allows our route relay R32 (Baring 2) to operate the DL3 and DLS relays.

7.08 Our second example was a call to Murdock 7; delete the A and B digits. The route relay assigned is R33. In the same cross connection table, we can see that DL2S stands for deletion of A and B digits with no 11 prefix. And so we cross-connect DL33 to DL2S. This would cause the route relay to operate DL2 and DLS relays.

7.09 The last example was a call to Fairview 3. The route relay is R25. It is reached through a tandem center and so we pulse all seven digits. This means we delete no digits. In the cross connection table we find that punching DLOS represents this condition. Cross-connect DL25 to DLOS. This causes DLO and DLS relays in the marker to operate on this call.

7.10 There is one example which differs in principle from these. On intra-office calls for message rate subscribers where AMA trunks are used, the marker attaches a sender. This is so because the sender acts as the liaison between the crossbar and automatic message accounting equipment. The marker must use a sender on intraoffice AMA calls. The sender doesn't pulse. We use the NDI punching (no digits - intraoffice) for this. For our central office which we have followed on the operational sketches, DL21 (the DL punching of route relay 21 - the IAO AMA route relay) is cross-connected to NDI. This sends an indication to the outsender that tells it not to pulse digits.

7.11 The marker also transmits class control information to the outsender.

This part comes off of the CL- punching of the route relay. There is a CL- punching for each route relay and it is numbered the same as its route relay. There are twelve class punchings in the marker numbered CLOS to CL5S and CLOP to CL5P. Each route requiring a sender has its route relay CL- punching cross-connected to one of the twelve class punchings. These class control relays cause the marker to transmit various kinds of information. The particular kind of class control needed depends on the kind of pulsing, kinds of trunks, etc. Part 7 on sheet D9 of the marker drawing - SD-26002-01 - describes the several features of class control. Whatever kind of class information is used on a call is checked by the marker to see that it is locked up in the sender. The class check operation is discussed in a later paragraph.

7.12 If one arbitrary digit is to precede the numerals of a called number, the CR cross connection in the marker is used on the route. The marker grounds the CR- leads through the outgoing sender-connector to operate relays $CR \frac{2}{5}$ (code route) in the outgoing sender. The $CR \frac{2}{5}$ relays are used to record the arbitrary digit preceding the numerals of the called number. Arbitrary digits are used to give a physical, theoretical, or extheo code indication. They are also used to give an office A or an office B indication to the terminating office, or as directing digits for step-by-step tandem. If these relays are not operated, the sender DCR (delete code route) relay operates to bypass the arbitrary digit relays.

7.13 In dial pulsing senders, it is possible to affix one, two or three arbitrary digits. If two or three arbitrary digits are to be prefixed to the outpulsed number, the ARN, BRN, and CRN cross connections in the marker are used on the route, as required. The marker grounds the AR-, BR-, and CR- leads through the outgoing sender-connector to operate relays $AR \frac{2}{5}$, $BR \frac{2}{5}$, and one $CR \frac{2}{5}$ (arbitrary digit) in the outgoing sender. When a converted code consists of two arbitrary digits, the tens digit is determined by relays $BR \frac{2}{5}$ and the units digits by relays $CR \frac{2}{5}$. When a converted code consists of three arbitrary digits, the hundreds digit is determined by relays $AR \frac{2}{5}$, the tens digit by relays $BR \frac{2}{5}$, and the units digit by relays $CR \frac{2}{5}$.

8. Check of the Information in the Sender -- Non-AMA Call

8.01 The marker has passed the necessary information to the outsender for a non-AMA call. It gives the sender time to lock up the information and then cuts off the grounds which operated the marker and sender relays. If

the sender has successfully locked in all the information, it returns a ground on each of the several leads used. This ground holds up the particular relay in the marker that is connected to the lead. The marker then checks to see if all the relays remain operated. In Paragraph 7.04 of this section, we checked for two out of five of the dialed digits by operating the ORK1 and ORK2 relays in series. The marker will cut off the operating grounds that operated these relays and then check if the ORK1 and ORK2 remain operated. It performs a check similar to this for the class, delete and arbitrary digit information.

8.02 On FS64 of SD-26002-01 (completing marker), we examined the class and delete relay operation. For our particular call we have one of the CLO to 5 and either CLP or CLS and one of the DLO to 6 and either DLP or DLS relays operated. To get down to particular cases let's assume we have an individual flat rate customer in Podunk 5 calling a subscriber in Mission 3. This is a free call; no AMA features are involved. If we assume that Mission 3 is also a No. 5 crossbar office, then we can assert that multifrequency pulsing would be used. A look at the cross connection table, Part 7 on sheet D9 of SD-26002-01, tells us we should cross-connect CL31 (CL punching of Mission 3 route relay) to CL2S. This operates CL2 and CLS relays on FS64. This particular class doesn't send a signal to the sender. However, we must operate class relays in the marker in order to provide a checking path.

8.03 The delete information was discussed in detail in previous paragraphs. Let us simplify; say for this call that we want to output the four digits of the telephone number and delete the A, B and C digits. Looking at Part 6 of the cross connection table on sheet D8, SD-26002-01, we see that we must cross-connect our route relay punching DL31 to DL3S. This operates the DL3 and DLS relays in the marker. The DL3 relay grounds the DL3 lead to the sender, operates the DL3 relay in the sender which locks and returns ground back on the lead to hold the marker DL3 relay operated. See FS69 on SD-26002-01. The ground for operating the DL3 relay in the sender comes through operated TGS1 contacts (transmit ground supply relay). This relay was operated when the marker started to seize an outsender connector. The TGS1 relay supplies grounds for any delete, class, code route (compensating resistance) leads that must be grounded by the marker for outsender information.

8.04 A sender can be made to send out one, two or three digits before pulsing the regular complement of digits. Such digits as these are called arbitrary digits. They are controlled by the connection on the CR- punching of the route relay. These digits are used in complex numbering areas where certain central offices have the same digits. In this situation, one of the conflicting codes is given an arbitrary assignment to replace its central office code. The subscriber isn't aware of this, however. He dials the regular office code. The route relay for this route has its CR- punching connected to one of the CRO to 4P or CRO to 5S punchings shown on FS62. This connection is used where one arbitrary digit is assigned to a route. For two or three arbitrary digits the code conversion relays CV- are used. FS62 shows this feature. If any arbitrary digits are required, the marker passes them to the sender and checks that they are locked up in a way similar to the delete and class information. However, for the particular call we set up in Paragraph 8.02, no arbitrary digits are required. In cases like this, the CR- punching of the route relay is connected to the CR5S terminal. So for our route, we cross-connect CR31 to CR5S on FS62.

This operates the CR5 and CRS relays in the sender. On FS66 we see how the different CR- relays that are operated causes either the CRK1 or CRK2 relays to operate and how they also send a ground to operate a relay in the outsender. The contacts of CR5 do not appear in this circuit. Because we don't want to set up any kind of arbitrary digit information in the sender, we used this relay for our call. However, some one of the CR- relays must be operated so as to provide a checking circuit path for the marker.

8.05 On FS77, when the outsender connector relays operated to let all this information pass to the sender, the marker operated its OST1 relay (outsender timing). The OST1 then operates the timed-operate OST relay. The OST operates OST2 and then OST2 starts the action to cut off all the grounds which operated the marker and sender relays. It first releases the KG relay on OS 719-1, sheet 2. This in turn releases the gating relays which cut off the ground supplies from the originating register that operated the various digit register relays in the marker and outsender. If the sender has all the digits locked up, it will return grounds back on these leads to the marker which hold up its own relays as well as the markers. If this is successful, the ORK1 and ORK2 relays in the marker remain operated.

8.06 The OST2 relay also opens the path of the TGS1 releasing it. The TGS1 then removes the ground supplies for operating the CLK-, DLK- and CRK- relays which were operated on FS66, FS67 and FS69. On our call, we decided that DL3 lead would be grounded. This operated DLK1 relay on FS69. The released TGS1 removes the operating ground but the sender returns its locking ground on the lead to keep DLK1 operated. We also decided, on this call, that no class leads to the sender would be operated. Yet in the marker, the CL2 and CLS relays are still held operated by the route relay.

8.07 When the OST2 relay operated, it released the OST1 on FS77. The OST1 in releasing releases the OST timed release relay. Now we can operate the RSC (registration sender check) relay. This is the relay which is going to check that all the relays operated in the marker are still being held by the sender. Because the path of the RSC relay is intricate, we will examine it here. It operates through the normal XT5, AMA5, NDL, NDK, through either CVS normal or H wiring, CR5 operated for our call, CL2 and CLS operated for our call, DLK2 and DLK1 operated, normal AMA3, operated ORK1, ORK2 and OST2, normal OST, OST1, OSEL and operated OST2.

8.08 When the originating register connected to the marker, it grounded a lead to the marker which operated the OR relay. This identified the call as coming from an originating register. On FS77, we can see that the OR operated the GTL and GTL2 relays. On an outgoing call such as we are following, which is not an AMA charge call, the GTL and GTL2 relays remain operated until the marker disconnects. On FS1, the operated GTL2 relay allowed the calling line location to be passed into the marker where it was stored in a relay circuit. On FS2, we see how the contacts of these relays provide a checking path for the RK1 and RK2 relays. The marker functions for transferring the calling line location from this relay to the relay which controls line link frame seizure, is the same in an outgoing call as it is in the call-back stage of the intraoffice call. This process can be reviewed in Section 5 - Intraoffice Call.

8.09 When the marker has operated RSC, it has an indication that all the required information has been successfully transmitted to the sender, is locked in and that the sender has returned a ground to the marker on each lead used. Now the marker can release the common channel in the outsender connector.

On OS 729-1, we see how the operated RSC releases the OSC. The OSC in turn releases the MP- and multicontact relays that provided the common channel between the senders and our marker. However, the marker still keeps a few leads in the individual channel. These will be used to control the sender functions later on in the marker's SOG job. On OS 730-1 we can see that the S- relay which has been operated, will continue to be locked up until the marker disconnects. This S- relay is associated with the sender we are using and with our marker. In other words, in an outsender connector there is an S- relay for each sender, for each marker.

9. Check of the Information in the Sender -- AMA Call

9.01 When an AMA charge is involved in a subscriber outgoing call, more information must be considered by the marker and passed to the sender. This information is the calling subscriber's line location, the central office code structure, the structure of the called telephone number, whether the calling subscriber is a tip or ring party and message billing index.

9.02 On OS 716-1, sheet 3 suppose a 2-party message rate subscriber in Podunk 6 is calling a subscriber in Baring 2. If we trace the route relay path through R32 to SC14 and through operated screening relay S38 (this is his assigned S- relay - see OS 715-1, sheet 3) we see that the route series relay is MBS1. One of the MBS1 to 9 relays operate when an AMA charge is involved.

9.03 On FS42 of SD-26002-01, we see that the MBS1 relay operates AMA relay. The path is through FN normal, MBS1 operated, normal FN, OPR, BL, VP and CAA relays to ground. On FS78, the AMA operates AMA3, 4 and 5. On FS60, the AMA3 allows the MC and SC multicontact relays to operate in the outsender connector. These relays pass to the sender the additional information mentioned in Paragraph 9.01.

9.04 On FS64 we see a punching CP- associated with a route relay. Each route relay has a CP terminal numbered the same as its route relay. For our call to Baring 2 the punching is CP32. It should be connected to one of the CPO to 9S or CPO to 9P terminals according to Part 5 of the cross connection table on sheet D8 of SD-26002-01. On our call there are three digits in the called office code. We have three choices for our cross connection. They are CP3P, CP3S, CP8P and CP8S. However, each of these four terminals represents a different number structure of the called telephone number. The terminals are explained in Table B. They are used for four different kinds of telephone numbers.

TABLE B

Central Office Type	Number Central Office Code Digits	Typical Tel. No.	Cross-Connect Route Relay CP- Terminal To	Number Structure
1. Dial - Less than 10,000 Lines	0	1234	CP0P	4DG
	1	A1234	CP1P	"
	2	AB1234	CP2P	"
	3	ABC1234	CP3P	"
2. Dial - With Numbers Over 10,000	0	1034 or 10345	CP0S	5DG
	1	A1034 or 10345	CP1S	"
	2	AB1034 or 10345	CP2S	"
	3	ABC1034 or 10345	CP3S	"
3. Manual With Individual Lines, Party Lines and Individual Lines Higher Than 9999	0	1034, 1034J or 10345	CP5P	15D
	1	A1034, 1034J or 10345	CP6P	"
	2	AB1034, 1034J or 10345	CP7P	"
	3	ABC1034, 1034J or 10345	CP8P	"
4. Manual With Individual and Party Lines - No Numbers Over 9999	0	1234 or 1234J	CP5S	15T
	1	A1234 or 1234J	CP6S	"
	2	AB1234 or 1234J	CP7S	"
	3	ABC1234 or 1234J	CP8S	"

9.05 The CP32 punching of the Baring 2 central office route relay is cross-connected to one of the punchings according to which one of the four general categories it comes under. If Baring 2 is a crossbar office then we connect CP32 to CP3P. This connection would allow the Baring 2 route relay to operate CP3 and CPP relays on FS64. On FS70, we can see that the CP3 relay grounds the CP1 and CP2 leads to the sender when the TGS2 operates. The CPK1, 2 relays also operate and will perform the check of these leads for the marker.

9.06 The CP3 and CPP relays also ground 4DG lead on this page. The operated TGS2 supplies the ground and operates NSK1 relay (number series check). NSK1 will perform the check of these leads similarly to the other lead-checking relays.

9.07 The MBS1 relay which we operated in series with R32, the Baring 2 route relay, sends message billing information to the sender. On FS68, the MBK (message billing check) relay operates if one MBS- is operated. The operated MBS1 and MBK ground MBO and MBI leads to the sender, operating the MBO and MBI relays there and also operating MBK1 and MBK2 in the marker. The operated TGS2 supplies the ground.

9.08 On FS65, the SCC operates from the operated OGC. The SCC relay (service call) operates on all customer calls; the TVA (transverter test) operates on AMA test calls. Either NOB or OBS operates from a ground in the originating register depending on whether or not our call is observed. On FS69 these relays send signals to the sender so as to operate appropriate relays and also operate check relays - MBK1, 2, 3 - in the marker.

9.09 On FS1 we see how the calling line location passes from the register to the marker through contacts of the GTL2 relay, and then on to the sender through operated MC and SC in the outsender connector. Part of the information needed to complete a successful check of the calling subscriber's line location is the number of the line link used on the dialing connection. On FS46 we see how this information passes from the originating register to the marker and is stored on two out of five of the LL- relays. On FS2, the RK1 and RK2 (registration check) relays operate in series through a checking path of the calling line location relays and the line link relays. RK1 and RK2 operate RK3.

9.10 On FS42 we can operate the CLG (class control ground relay) through operated AMA4, RK3 and ON FS77, operated TGS2, AMA3, TGS1, ORK1 to 2, KK and through the operated outsender connector multicontact relays to ground. CLG operates OST1 on this sheet. The OST relay is timed operated to give the sender a chance to lock up the information and return grounds on the leads, to the marker. The OST operates OST2 which opens the paths of the gating control relay KG on this sheet. The gating relays cut off the operating grounds of the A-L digit register relays from the originating register. The operated OST2 releases the GTL, GTL2, TGS1 and TGS2 relays. These four relays remove the ground supplies that operated the various information relays in the marker and outsender. However, the marker and sender relays will remain operated to the locking grounds supplied from the sender.

9.11 There is one more piece of information to consider on this call; it is the tip or ring party indication of the calling subscriber. On FS10, we see how the normal TP1 and TP2 relays in the originating register operate the RP and RPA relays in the marker. The TP1 and TP2 relays operate when the calling customer is the tip party of a 2-party line. This gives the marker a TP (tip party) indication. On all other calls, the RP (ring party) relay operates. On FS43 we see how the operated RP and CLG operate the RPK in the marker and RP in the sender. The sender returns a locking ground to hold operated its RP and the markers RPK after the CLG is released. If the call were from a tip party then the TP in the sender would operate from the TP in the marker.

9.12 Now the marker is ready to make a check of the successful transfer of the information. When the ground supply relays KK, TGS-, GTL and GTL2 on FS77 release, OST1 releases. OST1 times down the OST relay. If our transfer is successful we can reoperate GTL and GTL2 in parallel. The path is through operated RK2, RK1, AMA3, normal ND1, NDK, CVS, operated CR5, CL2, CLS, DLK2, DLK1, CPK1, CPK2, NSK1, MBK1 to 4, ORK1, 2, OST2, normal OST, OST1, OSE1 and operated OST2.

9.13 When the TGS2 relay released it opened the path of the CLG relay. On FS42, we can operate the CLK relay. Its path is through the operated AMA4, normal CLG and NS1, operated SON and RP, normal TP (number one contact), normal TP again (number two contact), normal TPK, operated RPK, RP, AMA and AMA4. Of course for a tip party call, the TP and TPK relays would be operated and the RP and RPK would be normal. Now we can operate the RSC on FS77. Its path is through normal XT5, operated OGC, CLK, GTL, normal OST1, operated AMA3, OST2 and OGC. The RSC starts the release of the outsender connector circuit.

9.14 When a call involves an AMA charge, the marker determines the AMA recorder assignment of the selected trunk and passes it on to the sender. It checks this information similarly to the other information passed to the sender. Actually this process takes place before the marker releases the outsender connector. On FS79 we see the trunk class relays ONN to 9NP. Trunks associated with AMA equipment have a cross connection from their associated KT or RN-punching to one of the ten ONN to 9NP punchings in the trunk link frame. There is a KT or RN punching for each trunk link frame appearance. The A appearances are designated RN--, and the B appearances KT--. They are numbered according to the switch and level appearance of the trunk. The ten punchings ONN to 9NP represent the ten maximum AMA recorder numbers to which a trunk can be assigned. For example, if our outgoing trunk is on an A appearance, switch 5, level 2 and is assigned to AMA recorder 1, we should cross-connect RN52 to LSE.

9.15 On FS78, we see the operating path of the RN relay. Where RN operates, it allows the LSE relay, which is operated on our call, to operate RNO and RNL. This circuit transfers the AMA recorder number from a one-out-of-ten indication on the ONN to 9NP relays to a two-out-of-five indication on the RN relays. When RNO and RNL operate, RNT1 operates. The path is through either NOB or OBS operated (observed or nonobserved), normal RNT2, RNT, operated RN 2/5 (RNO and RNL on this call) operated MBK5, AMA5, normal RNT2, to ground through the outsender connect relays. RNT1 times operated the RNT (recorder number timer). RNT operates RNT2 through the same path which operated RNT1. The RNT2 opens the grounds which operated the RN 2/5 relays in the marker and sender and also RNT2 releases the RN relay. The marker and sender RN 2/5 relays remain operated to the locking ground supplied by the sender. RN also releases RNT1 and this times down the RNT. When RNT releases, RNK1 and RNK2 operate in series if the transfer of recorder number to the sender has been successful.

10. Building the Channel

10.01 The information necessary to select the line link frame is transferred from the originating register and stored in the marker. This information is used to identify the line link frame on which the calling line is located. The operations for selecting the line link frame are described in Section 5 - Intraoffice Call.

10.02 The marker proceeds to seize the line link frame after it has seized the trunk link frame. The operation of relay TFK2 (trunk frame check) completes the operating path for relay MP- in the line link frame (OS 703-1). The operation of relay LFK (line frame check) indicates the seizure of the line link frame.

10.03 Junctor control is similar in operation to that described in Section 5 - Intraoffice Call.

10.04 Channel test and selection are similar in operation to that described in Section 5 - Intraoffice Call.

10.05 The operation for releasing the channel used in establishing the dialing connection is similar to that described in Section 5 - Intraoffice Call.

10.06 The operation of the select and hold magnets is similar to that described in Section 5 - Intraoffice Call.

10.07 The false cross, continuity, and double-connection tests are similar in operation to that described in Section 5 - Intraoffice Call. However, relay DCT1 (double-connection test) is not operated until the advance indication is sent to the outgoing sender and the relay AVK1 (advance check) is operated.

11. Advance Signal and Linkage Check

11.01 When the connection between the outgoing trunk and the calling line is completed, the marker operates the sender AV (advance) on relay FS49, SD-26002-01. When AV in the sender operates, it operates AVK (advance check) relay in the marker. The operated AV relay in the sender allows it to go on with its trunk test then output the digits.

11.02 Before releasing, the marker checks the channel linkage between the calling line and the outgoing trunks. If this channel is correctly set up and tested, relay LK1 (linkage check) operates to indicate that the channel is ready for service. Under heavy traffic conditions, the operation of relay LK1 operates the DIS1 and DIS2 (disconnect) relays. The marker now starts to release. The release of the marker is similar in operation to that described in Section 5 - Intraoffice Call.

11.03 The advance and linkage check relay paths are spelled out below. A bar under relay means it is normal.

AV relay (non-AMA call) FS49

S(OSC) RSC AMA5 PCL2 SLK2 SOG1 SP MT17 DCT CKG4 GT1 FLG GT5 PU.

AV relay (AMA call) FS49

S(OSC) RSC RNK1 RNK2 AMA5 PCL2 SLK2 SOG1 SP MT17 DCT CKG4 GT1 FLG GT5 PU.

AVK1 relay FS61

FKA, AVK, OSC-, OSE, SON.

DCT1 relay FS49 - noncharge call

LK1, RV3, SOG1, TTK, OTT, CLK, NOC, OGC, AVK1, SOG1, SP, MT17, DCT, CKG4, GT1, FLG, GT5, PU.

DCT1 relay - charge call

Path is same as for non-AMA call, except CLK is operated, NOC normal.

The CLK relay is operated on AMA calls (intraoffice and outgoing) to check the transfer of the ring or tip party signal to the sender. On non-AMA calls when the trunk must receive a class signal from the marker, the class check (CLK)

relay is operated. On non-AMA calls, when the route relay is either NCCN, TCCN or TCNC, the marker must send class signals to the trunk and go through the class check process. Reference sheet RM 702-1 lists various trunks, class signals and relays operated in the marker and trunks.

LK1 relay -

TOG2, DCT1, DCT2, DCT, CKG4, GT1, FLG, GT5, PU.

12. Marker Disconnect and Trunk Test

12.01 If the marker happens to be in heavy traffic while performing an SOG job with a sender, it disconnects in the usual manner. If the marker should be in light traffic, the disconnect operation is held up until the sender sends a successful trunk test signal to the marker. This signal indicates that the sender has made a successful continuity test on the conductors of the trunk from the sender through the outsender link, outgoing trunk, trunk conductors and circuit of the incoming trunk in the distant office.

12.02 If the marker is in heavy traffic, its HTR relay is operated during the SOG job. On FS50 of SD-26002-01, the DIS1 and DIS2 relays operate in parallel.

DIS1 and DIS2 - Heavy Traffic

MT1, MON1, TRL1, TRR, TRL, HTR, RRK, RRC, PSR, TSR, SOG1, RK3,
FMK, FML, MT17, ITR2, LK1.

12.03 If the marker happens to be in light traffic during an SOG job using a sender, the disconnect operation is held up until the sender makes trunk test. To discuss this point, we must go back to the seizure of the sender by the marker. On FS50, the TG (trunk guard) relay in the marker operated when the ON in the sender operated. This relay remains operated while the marker completes the outgoing job. When the marker finally operates the AV relay in the sender, this is a signal for the sender to start its trunk test functions. The sender places a test relay in series with the trunk conductors. Meanwhile the marker has progressed to the point where it operates the DIS1 and DIS2 relays. The path for operating these relays is opened by the operated HTR relay. The marker TGT (trunk guard test) relay operates to the ground instead. On FS50 the path of the TGT is:

TG, HTR, RRK, RRC, PSR, TSR, SOG1, RK3, FMK, FML, MT17, ITR2, LK1.

The TGT operates and locks through operated TG and its own contacts to ground. When TGT operates, it provides an operating path for the DIS1 and DIS2. When the sender completes trunk test, it opens the TG lead to the marker through its operated TGT relay, releasing the marker TG relay. TG releases TGT and marker disconnect is accomplished.

12.04 If, for some reason, the trunk is not a continuous circuit, the sender will not operate its trunk guard relay. The TG relay in the marker will remain operated holding up the TGT. The TGT will keep operated the DIS1 and DIS2. When the TGT relay first operated, it started a timer in the marker. On FS110, we see how TGT operates the SFT (seize frame timer) relay. The SFT relay starts the SDT timing circuit. The marker allows the sender the operating time of this SDT timer to complete trunk test. If it doesn't get an OK test signal from the sender in time, then the SDT timer operates. This causes the marker to print a trouble record.

12.05 The operated TGT relay locks up those relays in the marker which pertain to trunk and sender selection so that the indications of their selection will appear on the trouble card. On OS 729-1 we see that the operated OSG- relay locks to the TGT. This allows the sender group to appear on the card. The OSG- holds up the SON. On OS 730-1, the SON locks up the selected OS-. This gives us the sender OS- punch on the card. The OSE locks to the SON and the OSK locks up to the OSE on this sheet. On OS 731-1 the SSA or SSB is held up to the OSK. Now we have the sender group, subgroup and sender selections on the trouble record. On OS 702-2, sheet 1, we can see how the operated TGT locks up the operated FS- relay on this call. This gives us the trunk link frame number of the outgoing trunk. On FS25 of SD-26002-01 we see how the TGT relay locks up the operated TB- relay on this call. This gives us the level of our trunk on the trunk switch. On FS29, the operated TS- relay locked up to the TGT. This gives us the trunk switch of our selected trunk. All this information appears on the trouble card. These trouble cards have an identifying punch - TGT.

13. Outpulsing the Digits

13.01 Each of the different senders operates and performs various tests and functions differently than the others. We will not go into a detailed discussion here. We have examined the subscriber outgoing job and have dwelled on those points and operations which are different, involved or complex. The remainder of the call - the sender outpulsing - can best be followed in the circuit descriptions. The dial pulse sender is CD-26050-01, the multifrequency sender is CD-26051-01, the revertive pulse sender is CD-26052-01 and the panel call indicator sender is CD-26053-01.



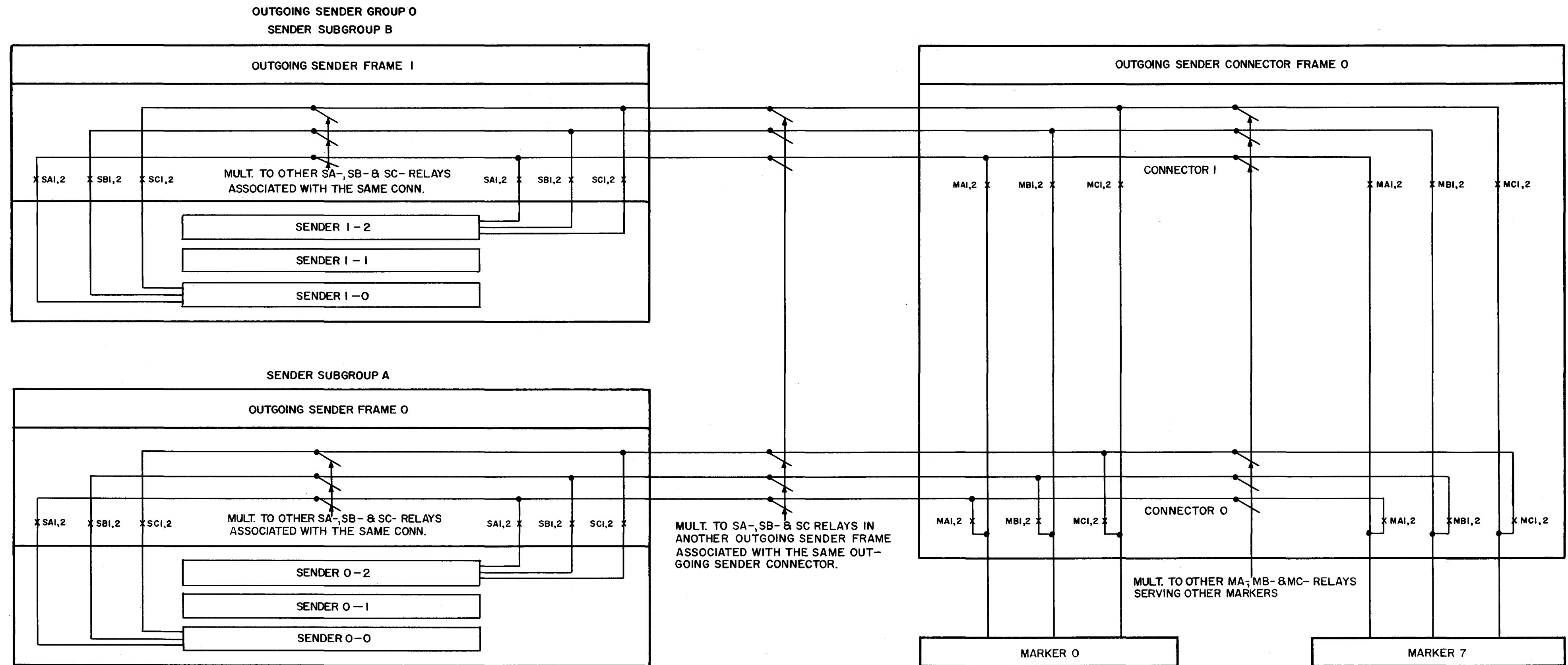


FIG. 2--THE COMMON CHANNELS BETWEEN MARKERS AND SENDER SUBGROUPS

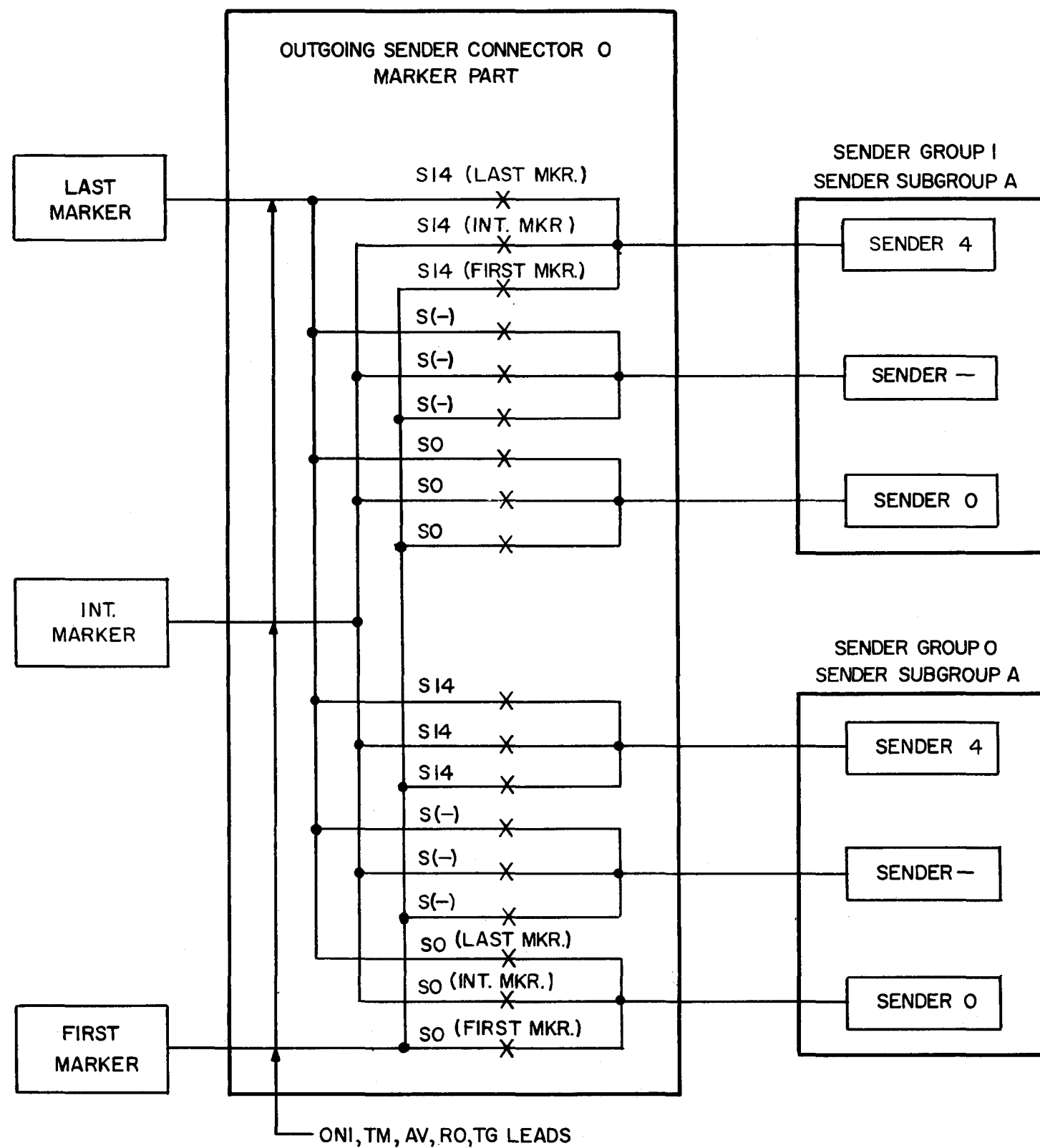
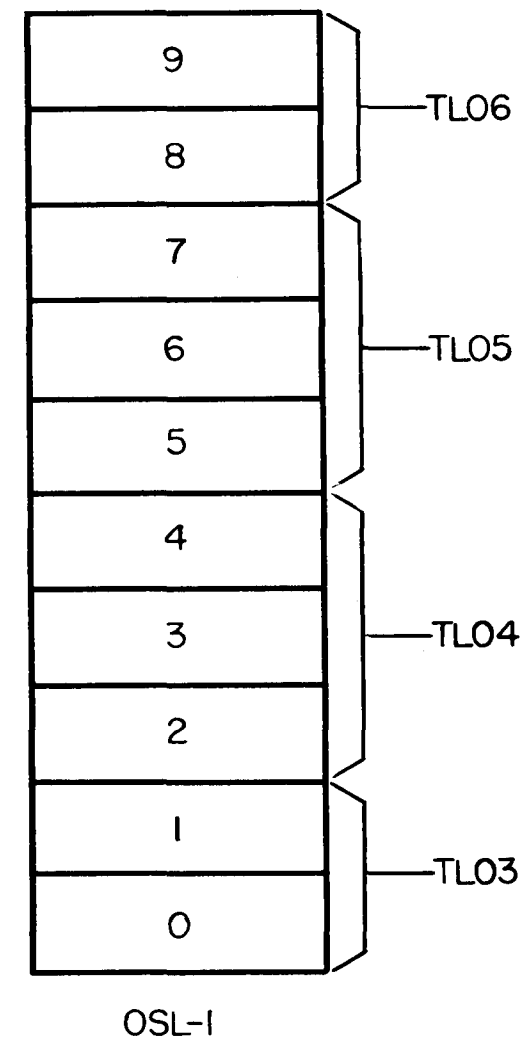
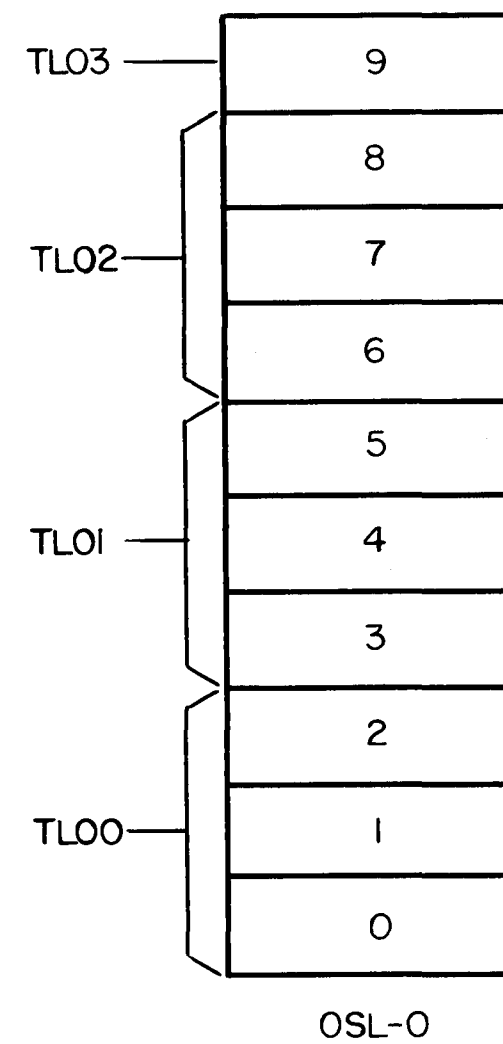


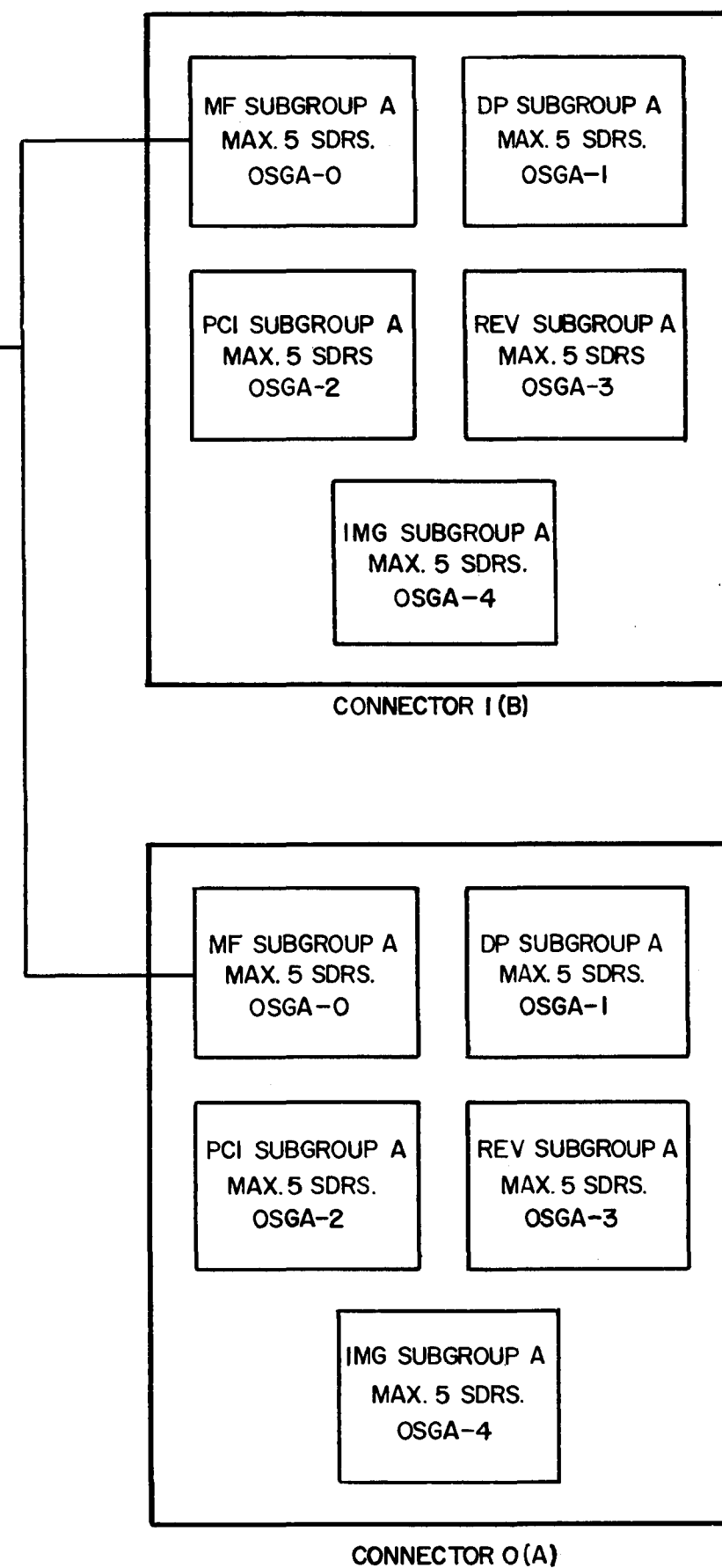
FIG. 3 — THE INDIVIDUAL CHANNELS BETWEEN MARKERS AND OUTGOING SENDERS



TYPICAL ARRANGEMENT OF
ASSOCIATION OF OUT SENDER
LINK SWITCHES WITH TRUNK
LINK FRAMES.

ONE OUTSENDER GROUP
MAXIMUM TEN SENDERS
OSG-0

THERE CAN BE A MAXIMUM OF FIVE
SENDER GROUPS IN A CONNECTOR,
HOWEVER THE SENDERS IN THESE
GROUPS CANNOT EXCEED FIFTEEN.
MAXIMUM FIFTEEN SENDERS IN A
CONNECTOR.



SECTION 7

INCOMING CALLS



INCOMING CALLS
NO. 5 CROSSBAR OFFICES

CONTENTS	PAGE
A. INTRODUCTION	2
B. ESTABLISHING THE INCOMING CONNECTION	2
1. Description of Incoming Register Links	2
2. Connecting An Incoming Trunk to An Incoming Register	4
3. Incoming Trunk Class and Trunk Link Frame Number	6
Trunk Link Frame Number	7
4. Transfer of Trunk Directory Number	7
5. Link Release Check	9
6. Impulsing - Dial Pulse Registers	10
7. Impulsing - Multifrequency Registers	11
8. Signal Receiving Circuit	12
9. Marker Start - Dial Pulse and Multifrequency Incoming Registers	17
General	17
10. Incoming Register Connects to a Marker	18
11. Trunk Link Frame Seizure	19
12. Trunk Link Frame - Link Connector and Select Magnet Operation	20
13. Priming the Incoming Trunk for Charging	20
14. Marker Selects Number Group to Locate Called Line	20
15. Number Group Locates Called Line and Transfers Information to the Marker	20
16. Releasing the Number Group	20
17. Selecting the Line Link Frame	20
18. Operating the Called Line Identification Relays	21
19. Number Group Makes Ringing Selection	21
20. Junctor Control, Channel Test and Channel Selection	21
21. Operating the Select and Hold Magnets	21
22. False Cross and Ground and Continuity Tests	21
23. Ground, Loop and Receiver Off-Hook Tests	21
24. Sleeve Double Connection Test and Holding Ground Check	21
25. Releasing the Select Magnets	21
26. Marker and Register Release	21
27. Ringing and Disconnect	22

A. INTRODUCTION

1.01 This section is one of a group which describes the detailed circuit operation of the various types of calls handled by the No. 5 Crossbar System with wire spring relays.

1.02 Calls that originate in one central office and terminate in another are interoffice calls. Those originating in the central office are outgoing calls; those terminating in the central office are incoming calls. This section describes the operation of incoming calls. Section 6 describes the operation of outgoing calls using senders.

1.03 The terminating (called) office receives these calls over incoming trunks which are seized from the calling end. The called line directory numbers are pulsed over the trunk conductors and stored in an incoming register in the called office. Three types of incoming registers are provided:

- (1) Dial pulsing (DP).
- (2) Revertive pulsing (RP).
- (3) Multifrequency pulsing (MF).

A table in Section 1 of this volume describes the conditions which require the use of these registers.

1.04 The pulsing operation of the incoming registers is described in the circuit description sheet (CD) of each incoming register. This process will not be repeated in this section.

1.05 When the incoming trunk is seized from the calling end, it seizes an incoming register through the incoming register link. The calling office passes the called number into the register, which then seizes a completing marker through the incoming register marker connector. The marker then establishes a connection from the trunk to the called customer. The trunk controls ringing, talking, and disconnect for the call.

1.06 The general description of incoming calls is included in Section 1 of this volume. The entire operation is shown on SC 708-1. A progress diagram for the incoming call is shown in Fig. 41 of Section 1.

B. ESTABLISHING THE INCOMING CONNECTION

1. Description of Incoming Register Links

1.01 The numericals of the called directory number are passed over the trunk conductors, through the incoming register link, then into the incoming register. The links are mounted on incoming register link frames. Each frame consists of crossbar switches and control apparatus for selecting and seizing incoming registers.

1.02 There are two kinds of incoming register link frames (IRL). One has six switches and control relays in one bay. It has a capacity for 120 dial pulse by-link trunks. The limit of the capacity of this link arrangement is one bay - 120 trunks.

- 1.03 Another link frame is available for RP, MF and direct pulsing DP trunks. Its capacity is 160 trunks per frame. Each frame has eight crossbar switches and associated control relays. A second or third frame can be added to this basic frame. The three frame group provides for 480 trunks served by the same ten incoming registers. The capacity of the multifrequency and re-vertive pulse link groups is three frames - 480 trunks. The limit of the dial pulse link for direct pulsing trunks, is two frames - 320 trunks.
- 1.04 On any link frame or on any link frames making up an incoming register link group, all incoming registers must be the same kind, and, of course, it follows that all the incoming trunks assigned to an incoming register link group must use the same kind of pulsing.
- 1.05 There is no common control equipment present which can steer a trunk to the proper kind of incoming register, and so because of this all trunks and incoming registers are on incoming register link frame use the same kind of pulsing.
- 1.06 In the six switch, 120 trunk incoming register link frame, each crossbar switch is a horizontal group. The trunks on the link are then divided into six horizontal groups. These trunks compete with one another, within their horizontal group, for register preference. Simultaneous seizures of registers by trunks can occur so long as the trunks are in different horizontal groups.
- 1.07 The incoming trunks are assigned one trunk to each vertical of the crossbar switches. Vertical zero on the first switch is always assigned as a test position for the automatic monitor and incoming register test circuit.
- 1.08 Each frame of a group and each horizontal group of a frame can be identified by trouble card punches. There are three punches which are used to identify the frames in the three frame, 480 trunk link group. The first, RPB, identifies the basic or first frame. The second, RPAB, identifies the auxiliary or second, and the third punch RPSA identifies the second auxiliary or third frame in a group. If we have in an office a full incoming register link group serving 480 incoming trunks, these three punches break the link down into groups of 120 trunks each.
- 1.09 The RP- punches are used to further divide each frame. The eight crossbar switches on each frame are arranged into four horizontal groups of 40 trunks each. Fig. 1 shows the arrangement. Each two switches (one horizontal group) are represented by an RP- punch. Now we have broken down our 120 trunks on a frame into groups of 40 trunks each using the RPO to 3 punches. This is the smallest division obtained from the trouble card.
- 1.10 There is a slightly different assignment of the trouble card punches to the parts of the bylink IRL frame. This link group can only have one frame. However, the frame has six switches, each one a horizontal group. There are only five (RPO to 4) punches on the card. Here is how the identification works. The first five switches use punches RPO to 4 and also RPB. The last switch (horizontal group 5) uses punches RPO and RPAB. The assignment of punches to the horizontal groups does not fit perfectly because the card has been designed for the U and Y type link which had no more than five horizontal groups.

1.11 The incoming registers are assigned to the levels of the switches. An incoming register is multiplied to the same horizontal of each switch in the link group. For example, in a full 480 trunk incoming register link, there would be twenty-four switches served by ten registers. Every register would appear once on each of the twenty-four switches on the same numbered level of each switch.

1.12 This discussion has revolved about maximum size links. A link group need not have ten registers or its full complement of switches and trunks. Size depends on traffic requirements. The principle of operation is the same for any size.

2. Connecting An Incoming Trunk to An Incoming Register

2.01 The connection of an incoming trunk to an incoming register is controlled by three relay preference chain circuits in the incoming register link. These chain circuits are as follows:

(a) TP- (Trunk Preference) Relay Chain: One of these circuits is provided for each horizontal group on the incoming register link frames. There is a TP- relay for each trunk in the horizontal group. For a single switch, we have twenty TP relays in a chain. If there is a supplementary switch then there are forty TP relays in the chain. This chain determines which trunk seizes the register.

(b) RB- (Register Busy) Relay Chain: One of these chain circuits is provided for each horizontal group on the register link frames. There is an RB- relay for each register in each of these chain circuits. When an incoming register is busy on a call or out of service, its associated RB relays are operated in the link group. For a full size link, we would have twelve RB- relays for each register, one RB relay in each register busy chain for each horizontal group.

(c) RP- (Register Preference) Relay Chain: One of these chains is provided for each register. There is an RP- relay for each horizontal group which has access to the register. This chain determines which horizontal group seizes the register.

2.02 On OS 733-1 we have the circuit for the nonbylink incoming register link frame. When the trunk loop is closed at the calling office end, relay A in the incoming trunk operates. Relay A closes a battery start (ST) lead to the TP- relay for the associated trunk. The operation of the TP- relay opens the operating path for all higher numbered TP- relays. Lower numbered TP- relays may operate, but perform no function because the functional chains are opened by the operation of any higher numbered TP- relay. The operation of a TP- relay closes a ground start (ST) lead to the RB- relay chain. Operated RB- relays indicate that their associated registers are busy.

2.03 The starting points (ST leads) of the RB- chains are connected so that each horizontal group of trunks has a different first choice register. The initial preference of a horizontal group is for the similarly numbered register. This allows calls from different horizontal groups to be served at the same time.

- 2.04 The start ground on lead ST is applied to normal contact of relay RB- for the first choice register. If this register is idle, the ground is applied to its RP- relay. If the first choice register is busy, the ground is transferred to the next RB- relay contacts, etc.
- 2.05 If the start ground reaches a normal RB- relay, it is applied to the corresponding RP- relay winding. If this RP- relay is associated with a first choice register in the horizontal group, battery is connected directly to its winding, otherwise, battery is connected to its winding through normal contacts of other RP- relays in the chain.
- 2.06 There is a time interval during which more than one RP- relay in a given chain may operate. For example, let us assume that all registers except the ninth are busy (OS 733-1). If start leads are grounded in rapid succession in horizontal groups 0, 1, 2, 3, in that order, the corresponding RP- relays operate. The operation of any or all RP- relays grounds lead ON to the register, which operate register relays ON (off-normal) and RB (register busy). Relay RB extends resistance battery leads to all of its associated RB- relays. All of these relays operate except RBO, which is associated with the preferred RP- relay. This occurs because ground from the register is applied over lead LO (lockout). This ground shunts relay RBO, keeping it unoperated. The other RB- relays operate and switch ground from their RP- relays to the next RB- relays in their respective chains. The RP- relays release.
- 2.07 In order to prevent a horizontal group from reverting to a higher choice register, should one become available after a seizure, all operated RB- relays are locked when a TP- relay operates. The locking ground is connected through break contacts on relay RB- and is therefore effective only when one or more RB- relays are normal. This arrangement prevents a horizontal group from locking itself out of service if an all-registers-busy condition occurs. When the last available register is made busy, the locking battery is removed and any RB- relay corresponding to an idle register is then free to release, making the register available to the horizontal group.
- 2.08 On OS 733-1, sheet 2 battery is supplied from the register on lead SM- (select magnet) and passed through a contact of the operated RP- relay to operate the S- and SS- select magnets for the level to which this incoming register is assigned. Ground on lead OH- (operate hold magnet) is supplied from the register through off-normal contacts of select magnets and contacts of the highest number operated TP- relay to operate its corresponding LH- hold magnet. The crosspoint that is associated with the register and corresponds to the TP- number is closed. The operating ground from lead OH- passes through the crosspoint and returns to the register on lead HM-. Relay H (hold) in the register operates to check the crosspoint closure. In operating, relay H opens lead OH- and connects holding ground for the hold magnet through the primary winding of relay DCK (double connection check). If ground is supplied to the hold magnet from another register, lead HM- is grounded. This shunts relay DCK and prevents its operation. If lead HM- is not grounded, relay DCK operates in series with relay H. Relay H also opens lead SM-, releasing the select magnet. The hold magnet is now held by the register through the crosspoint and is independent of the preference chains.

2.09 Relay H operates the CO relay in the trunk when MF pulsing is used and operates the DP when dial pulsing trunks are used. DP in the register in turn operates CO in the trunk. In either case, the operated CO in the trunk opens the path of the A relay in the trunk. The H relay, when it operated, closed a path for operating the A relay in the register. When this occurs, the register assumes control of the incoming connection. The H relay also opens the battery for operating the select magnets associated with the incoming register.

3. Incoming Trunk Class and Trunk Link Frame Number

3.01 Incoming trunks to No. 5 crossbar offices are assigned certain classes.

These classes divide trunks into groups according to the traffic arrangements of the office. For example, incoming trunks which serve one central office designation are given a class such as OA (office A) or OB (office B). Incoming trunks which serve either of two such offices are given a class such as AB (office A and B). Other trunk classes are FVD (five digits) TAN (tandem) TOLL (toll). The class mark is handily used by the completing marker to identify the class or group of a particular incoming trunk on a call. Trunks are assigned to their classes by cross connections in the incoming register link. These cross connections for incoming trunks are recorded on assignment sheets. As an incoming trunk seizes an incoming register, the trunk class mark is passed through the link to the incoming register. The register stores the class mark until it connects to a marker after pulsing has been completed. Then it passes it to the marker.

3.02 On OS 734-1, sheet 3, we have some register connector relays in the link. There is a C- relay for each incoming register in each horizontal group. When any horizontal group contains trunks which have line link appearances (which require trunk directory numbers) a CA- relay is provided for each incoming register in that horizontal group. This drawing shows a CA- relay for each register in each horizontal group. We would have this arrangement if each of the six horizontal groups had trunks with line link frame appearances.

3.03 The C- and CA- relays are operated by the RP- relay which is operated. The RP- contacts are wired in a preference chain circuit. More than one horizontal group can have a demand in the link if they have simultaneous seizures of incoming trunks. If this happens, several RP- relays may be operated. However, the working contacts of the RP- relays are wired in a lockout chain so that only one RP- relay is effective.

3.04 On sheet 1 of this OS, we have some TP- relay contacts. The three horizontal groups shown represent the six complete groups of the 160 trunk link circuit. Each TP- relay has a terminal TPC-. The highest operated TP- relay grounds is associated punching. This TPC- terminal is cross-connected to a CL- punching according to the assignments for IRL cross connections. Each one of these CL- punchings represents an incoming trunk class. These punchings are wired to the contacts of ten C- relays. Only one can be operated at a time. The ten C- relays are numbered according to the horizontal group. On sheet 3, we saw how various horizontal groups compete for one another to get connected to the same register. On OS 733-1 we saw how the registers were wired in a chain circuit through the RB- relay contact chains. Of the ten C- relays in horizontal group zero on OS 734-1, sheet 1, only one can be operated at this time. It sends the eleven class leads to its own incoming register

where they terminate on a cross connection block. These punchings are cross-connected to the class punchings in the incoming register according to cross connection assignments. Through this path, an incoming trunk gives its class mark to the register. The register locks up the operated class relay.

Trunk Link Frame Number

3.05 There may be as many as twenty trunk link frames in an office. If there are more than ten, they are divided into two groups. Trunk link frames 0 to 9 are in frame group 0, and frames 10 to 19 are in frame group 1. All the trunks in any horizontal group on the incoming register link frames must be the same trunk link frame group. It is therefore possible to identify the tens digit of the trunk link frame number through the horizontal group on the incoming register link frame.

3.06 The C- relay which has operated to connect our incoming trunk to the selected incoming register has acted as a connector to pass class information from trunk to register. It also serves as a connector to pass the trunk link frame number, of this trunk, to the incoming register. On OS 736-1 we see some other contacts of the TP- relays of incoming trunks. Just as each TP- relay grounded a terminal for trunk class, it also grounds another terminal for trunk link frame units number. The cross connections from the TPU00 to 19 punchings in each horizontal group, are cross-connected to the TFO to 9 punchings according to IRL cross connection assignments. Because all the trunks assigned to one horizontal group must be in one group of ten trunk link frames, we use only one contact on the C- relay to indicate either G0 (frames 00 to 09) or G1 (frames 10 to 19). We use this arrangement in order to save relays and cross connections.

3.07 For any incoming trunk, we have two leads grounded from IRL to IR. The FGO or FGI leads operate the FGO or I relay. One of the leads TFO to TF9 is grounded. The TF leads carry trunk frame units number as one-out-of-ten information. The incoming register translates it into a two-out-of-five code. The grounded TF- lead operates one of the five TF- relays which in turn locks and operates TFT. This relay switches in incoming TF lead ground from the original TF- relay (which is locked up to ON ground) to the mate TF relay.

4. Transfer of Trunk Directory Number

4.01 Certain kinds of incoming trunks appear on line link frame verticals.

Any incoming trunk which can be connected to an outgoing trunk must have a line link frame appearance. Coin junctors, operator junctors, tandem incoming, and intertoll trunks have line link frame appearances. In order for the marker to locate this trunk vertical on a line link frame, we give the trunk a directory number. Actually, the trunk has two directory numbers. The hundreds, tens and units digits are the same. The thousands digits must be different. Trunks with directory numbers are assigned certain blocks of numbers in an odd and even numbered number group. If the number of these trunks requiring trunk numbers warrants it, we may provide two special trunk number group frames. In either case, each trunk which has a directory number, appears once in two number group frames. The two number group frames must be one odd and one even numbered frame. This is necessarily so because the marker does not select trunk number groups by the thousands digit; it merely uses an odd or even selection device for one of the two trunk number group frames.

4.02 On sheet 1 of OS 735-1, we see how a trunk is given a number by the cross connections in the IRL, and how this number is stored in an incoming register. On the left of the sheet, we have the contacts of forty TP relays in horizontal group zero. This example is typical of all horizontal groups. TP relays 00 to 19 are on the basic switch and TP20 to 39 are on the supplementary switch. The three contact chains of the TP- relays belong to one set of twenty TP- relays. The TP relay contacts of a trunk send three grounds through the link into the incoming register. One of these supplies the trunk hundreds number information, another the tens and the third the units information.

4.03 Starting at the bottom of the sheet, we can follow the trunk units number. Suppose that our incoming trunk is located on vertical nineteen (which is really numbered vertical nine on the right side of the switch) of basic switch zero. Its TP relay is TP19. Operated TP19 grounds the CU9 lead to the register through the operated CAO relay (this relay was operated in parallel with C0 when our trunk seized the incoming register). If we examine the other LU- leads for a moment, we can see that the LU- lead number is the same as the units number of the TP-- relay. This is always true. The trunk directory number units digit is the same as the trunk vertical number.

4.04 Ground on lead LU9 operates LU7 relay which locks to ON ground. LU7 operates LUT relay. This relay switches the incoming ground signal from LU7 relay to LU2, operating it. This gives us a two-out-of-five trunk units digit. All other grounded LU- leads work the same way. At first one of the two-out-of-five relays is operated and locked, then LUT operates and switches the ground to the mate relay.

4.05 The trunk tens digit information comes from another chain of contacts on the same forty TP relays. The tens digit number is the same for the ten verticals, zero to nine, on any switch. For instance, on this sketch we see that TP relays 00 to 09 ground the LTO lead through operated CAO connector relay. TP10 to 19 ground LTL lead. TP20 to 29 ground lead LTO (the same lead grounded by TP00 to TP19) and TP30 to 39 ground LTL lead (the same lead grounded by TP10 to 19). Since on this call, our trunk has operated TP19 relay, the ground from its contacts operates LTL relay in the incoming register. LTL locks to ON ground.

4.06 The grounding of the LT2 to LT9 leads, if they are equipped in the link, occurs in the same way as the process we just examined. The two sets of ten TP- relays associated with any switch, ground two LT leads. The nonbylink (120 trunk) link frame uses LT leads zero to seven. The 160 trunk link frame uses LT leads zero to nine which take care of five of the switches (ten half switches) and leads LTO and LTL are used again for the sixth switch, horizontal group five.

4.07 Now to examine the hundreds digit process. The top set of TP- relay contacts, on this page, give the trunk hundreds information. The first twenty TP relays, TP00 to TP19, are on the basic switch; they ground the A0 punching on nonbylink frames. The second group of TP relays, TP20 to TP39, ground punching B0 in a nonbylink frame. The TP00 to 19 relays are on the basic switch and TP relays 20 to 39 are on the supplementary switch of horizontal group zero. The A0 and B0 punchings are cross-connected according to

Note 3 on this OS. In any case, the cross connection will serve to operate one of the four relays REG, REG1, SUP, SUP1 in the MF register or one of two relays REG or SUP in DP registers.

4.08 The operated REG, REG1, SUP, or SUP1 relay and operated LT- relay in the register ground associated terminals. These terminals are cross-connected so as to translate the hundreds digit of the trunk number.

4.09 Actually there are several conditions which limit the assignment of trunk numbers to incoming trunks which require them. If the directory numbers assigned to these trunks fall in a subscribers number group series, then only those numbers reserved for trunks can be used. There are various limitations on the assignment of trunk numbers in the incoming register link groups. There can't be duplication of numbers. For instance, in the example above we had forty trunks in horizontal group zero. The first ten trunks (TPO to 9) are assigned LTO lead. The third set (TPO to 9 on the supplementary switch) use the same lead LTO. Obviously trunks in these two groups must have different hundreds numbers. This is controlled by the A0 and B0 punching cross connections. In any case, the units digit of the trunk number must be the same as its vertical number on the incoming register link switch. The tens and hundreds digits are governed according to the several frames of a link group. These limitations are spelled out in detail in notes in the schematic drawing of the Incoming Register Link Frame, SD-26048-01.

5. Link Release Check

5.01 After the trunk has been connected to the incoming register, after the crosspoints have closed and after the trunk passes the required information to the register, the incoming register makes a check to see if the information is stored properly. If it is, the check relay (CK) operates in the register. Then the register starts a timer which controls the length of the start pulse signal to the distant end. The process of making the check is timed by a special timer - LR (link release). If the check is unsuccessful, this timer operates and causes the incoming register to seize a completing marker immediately. The register passes to the marker all the information it has which is horizontal group (RP-), frame identity (RPB, RPAB, or RPSA), trunk class, trunk link frame number and trunk directory number. The marker in turn passes this information to the trouble recorder for the LR card which it produces. If the check is successful then the LR timer will not operate because the operated CK will prevent it. The register then sends a start dialing or start pulsing signal to the outgoing office.

5.02 The CK path for MF registers is shown on OS 740-1, sheet 2. It checks the frame group tens (FGO or FGL) and trunk frame units (TFT) trunk class (OA, OB, etc.). If the trunk class is TAN or TOLL, it also checks the trunk directory number (LT-, LUT, REG, SUP, Etc.). The path continues through the register busy relays to the IRL. The path through the RP- relay contact chain varies according to the preference position a register has in a particular horizontal group. Whichever horizontal group contains our incoming trunk, has its RP- relay operated. This takes the RL lead into the contact chain of TP-relays. The operated TP- relay which is highest in the preference circuit has to be the same one selected by the link control circuit, and also happens to be the one associated with our incoming trunk. In this example it is TP01; the trunk CO is supplying a ground to operate the CK relay in the incoming register.

5.03 The CK operates RLK which in turn starts the RV timer. When RV relay operates, it reverses the tip and ring through the register A relay. This reverses the battery and ground towards the outgoing office. The reversal supplies a start signal to the distant end. These operations can be followed on sheet 2 of OS 740-1.

5.04 The operation of the CK relay in the dial pulse incoming register is similar to the MF register. In both registers, when the CK operates it starts the RV timer and operates the RLK relay. The RLK relay releases the operated TP- relay which is associated with the incoming trunk. The RLK also allows the RB relay associated with this register, which has been shunted down to operate. The operated RB- relay transfers the start lead from this to a succeeding register. The TP- relay, being released, allows the next preferred trunk to put out a demand for an incoming register.

6. Impulsing - Dial Pulse Registers

6.01 A No. 5 crossbar office may use incoming dial pulse registers to receive impulsing from the following types of offices:

- No. 5 Crossbar
- Step-by-Step
- Manual (Operator positions equipped with dials)
- Panel Sender Tandem
- Crossbar Tandem
- Nos. 4, 4A, 4M, and A4A Crossbar Toll

The sequence of relay operations for incoming dial pulse registers is shown on SC1 on sheet E1 of SD-26041-01, the dial pulse incoming register schematic drawing.

6.02 When the register is seized by an incoming trunk, it receives and registers the dialed information together with the class of trunk. It then connects to a marker and transfers this information to it. The marker sets up the connections to the called party and the call is completed. Dial pulse incoming registers are arranged to receive pulsing from bylink or direct pulsing trunks. Bylink trunks originate in step-by-step offices. Pulsing on these trunks starts shortly after register seizure. A quick pulsing path is established through the control relays of the incoming register link, and pulsing is repeated from a relay in the bylink trunk. Direct pulsing trunks wait until a start pulsing signal is returned by the register.

6.03 When a direct pulsing trunk is connected to an incoming register, relay C- in the incoming register link operates the DP (direct pulsing) relay (OS 738-1). When the crosspoints are closed, relay DP operates trunk relay CO (cutoff). Relay CO removes trunk relay A from the tip and ring to provide T and R leads to the register. DP also operates L (line) relay. Relay CO sends a ground to the register, which checks the operation of the register class and trunk link frame number relays. Properly operated class and trunk link frame number relays are indicated by the operation of relay CK (class check). Relay CK closes the charging circuit to capacitor RV, and in about 140 to 300 milliseconds, tube RV conducts, operating relay RV (reversal). Relay RV reverses the tip and ring conductors. This is a start pulsing signal to the calling office. Relay RV also operates relay RV1. Relay RV1 removes the

holding ground from the ACC (abandoned call control). This ground holds the ACC relay during the interval when relay L may be released by the tip and ring reversal. Relay RV1 is slow operate, and maintains this ground during the momentary release of relay L. If dial tone is required, as in calls from an operator, relay RV1 connects ground to the TN (tone) coil, inducing dial tone on the tip and ring conductors.

6.04 Where step-by-step offices do not use senders, the customer dials directly and controls the pulsing of digits to the called office. The first one, two, or three dialed digits (office code) cause the step-by-step equipment to seize a trunk to the called office. If this is a No. 5 crossbar office, the incoming register must be ready to receive pulsing during the interdigital interval. This is done by an auxiliary or bylink path through the control relays in the register link. The operation of the register preference relays in the link circuit closes a path to operate register relay L from the trunk. The operated C- (class) relays in the link circuit indicate a bylink type of trunk and operate register relay BL (bylink). Relay BL prepares the register for the pulses. Relay BL also prepares a path for the operation of relay CK which checks that the class and trunk link frame number is recorded in the register.

6.05 The dial pulse counting feature records the number of pulses in each digit. When dialing of a digit is completed, the count is transferred to register relays. The counter then recycles to prepare itself for the next digit. The pulse dividing, pulse counting, and register relays operate in the same manner for both types of trunks. The operation of the various relays in the register is described in CD-26041-01, Incoming Register Dial Pulsing.

7. Inpulsing - Multifrequency Registers

7.01 A No. 5 crossbar office may use incoming multifrequency pulse registers to receive inpulsing from the following types of offices:

- No. 5 Crossbar
- Manual
- Nos. 4, 4A, 4M, and 4A Crossbar Toll
- Crossbar Tandem

The sequence of relay operations for incoming multifrequency pulse registers is shown on the SC's in the E section of SD-26042-01 - Incoming Register Multifrequency. The multifrequency incoming register is seized by an incoming trunk through the incoming register link. The register prepares itself for inpulsing and returns a signal to the trunk, indicating that inpulsing may start. A multifrequency receiving circuit is used with the register to translate the ac pulses into dc pulses which can be registered. Multifrequency pulsing and the signaling receiving circuit are described in Paragraph 8. After pulsing is completed, the register seizes a completing marker which completes the connection to the called number.

7.02 When relay RLK operates (OS 740-1), indicating that the trunk link frame number and the class information are recorded in the register, the RV tube is fired and operates the RV relay. Relay RV reverses battery and ground to the tip and ring conductors. This is recognized as a start-pulsing signal by the operator or outgoing sender. At the completion of the start-pulse signal, relay SP (start pulse) in the outgoing sender operates.

7.03 In this type of incoming register, receiving is done by the multifrequency receiving circuit. The frequencies are received and translated into dc pulses and passed to the register where they are recorded on a two-out-of-five code basis on registration relays A- through L- (OS 740-1). Associated with each registration relay is a digit-steering relay (AS through LS).

7.04 When the register is seized, the operated ON (off-normal) relay operates relay AS (A digit steering). The register proceeds to the operation of relay SP in the sender, as described in 7.02. When the KP (keypulse) signal is received, relays KP, KPl, and KP2 (keypulse) operate in the signaling receiving circuit (OS 740-1), indicating that the receiver is ready to receive digit frequencies. The A digit frequencies operate two corresponding channel relays on a two-out-of-five code basis. The operated channel relays operate the A digit register relays. The CK2 relay operates if two frequencies are received. The operated channel relays operate RA (register advance) which in turn operates the next steering relay (in this case, BS). BS restores the signal receiver to normal. When the digit tones are removed at the distant end, RA releases. RA releases the previous digit steering relay (in this case, AS) and the receiver and register are ready for the next digit.

7.05 The B digit is recorded in the same manner. Two of the B digit registration relays and the CS steering relay operate. The channel relays and the BS digit relays release. The rest of digits proceed in the same way. If the number of digits registered is less than the maximum number for which the register is equipped, a start signal is required for marker seizure.

8. Signal Receiving Circuit

8.01 A signal receiving circuit is provided for each incoming multifrequency register. The receiving circuit receives multifrequency signals (ac voltages) in the form of pulses over a trunk from a keyset or multifrequency sender. It converts these pulses to dc signals which are stored in the register and are used to control the receiver and the register.

8.02 Multifrequency pulsing makes use of six voice frequencies, spaced 200 cycles apart, to transmit the digits zero through nine and two additional signals. One of these signals, KP (keypulse), is sent at the start of pulsing and the other, ST (start), is sent when pulsing is completed. The frequencies are designated in a two-out-of-six coding arrangement. Table A shows the frequency designations with the digits and signals which they represent.

TABLE A

<u>Digit</u>	<u>Frequencies Designated</u>
0	4,7
1	0,1
2	0,2
3	1,2
4	0,4
5	1,4
6	2,4
7	0,7
8	1,7
9	2,7
KP	2,10
ST	7,10

Table B shows the frequency designations with the frequencies used.

TABLE B

<u>Frequency Designation</u>	<u>Frequency Used, CPS</u>
0	700
1	900
2	1100
4	1300
7	1500
10	1700

8.03 A signal receiver performs the following functions:

- (a) Establishes a fixed amplitude for the incoming signals.
- (b) Separates, by a filtering arrangement, the two frequency components of each pulse.
- (c) Converts the two ac components of the signal to dc for controlling and registering the digits of the called number.

8.04 The filaments of the vacuum tubes in the receiver are continuously energized, except when the receiver is removed from service. Signaling receiving circuit on OS 740-1 should be used with this description of the receiver.

8.05 The KP (keypulse) signal is a relatively long pulse of frequencies two and ten. It primes the receiver for the digit pulses. When the receiving circuit is connected to a multifrequency sender, there is a period when it is exposed to outside speech or noise currents. This might cause false registrations in the associated incoming register. To prevent this, the receiver is arranged so that it does not register digits until it is unlocked by a KP signal.

8.06 The input circuit consists of an IN transformer, an impedance-correcting network, and an IN input transformer. Transformer IN is so designed and shielded that the effect of outside currents which might cause false operations of the receiver are kept at a minimum. Resistors P1, P2, and P3 make up the impedance-matching network. Input transformer IN is used to increase the voltage of the signals before they enter the voltage limiter.

8.07 The volume limiter consists of vacuum tubes L1, L2, and their associated input and output circuits. The limiter controls the signal amplification to the extent that only the desired channels will operate. It also limits the volume of high-level incoming signals so that undesired channels do not operate because of "spill over" from adjacent channels. The limiting action is obtained by the control grid resistors and capacitors L1 and L2. The actual point at which limiting occurs is controlled by the screen grid and cathode voltages as well as the control grid voltage on tubes L1 and L2. Potentiometer P adjusts the screen grid voltages. The cathode voltage is obtained from the voltage drop across resistor L3. The output of the volume limiter is connected to three circuits:

(1) Signal present circuit (SP filter).

(2) Variable bias circuit.

(3) Channel filters.

8.08 The signal present circuit consists of the OUT (output) transformer, SP (signal present) input transformer, SP filter, BR vacuum tube, its associated resistors and capacitors, and the SP vacuum tube. The voltage from the output limiter is applied through filter SP and input transformer SP to grid No. 3 of tube BR. Tube BR functions as a rectifier because of negative grid bias supplied by potentiometer SP. The output of tube BR (a dc potential taken from its cathode) is connected through resistor P to vacuum tube SP after the KP signal is received and the KP condition established. Before and during the KP signal, tube BR is held nonconducting by a negative bias on grid terminal three. Vacuum tube SP acts as a dc amplifier and also operates relay SP, indicating the presence of a signal.

8.09 The variable bias circuit consists of half of vacuum tube BR, the grid bias control apparatus which is connected to terminal seven of tube BR, and the voltage doubler apparatus which is connected to terminal six.

8.10 During reception of the KP signal the variable bias circuit adds a negative voltage, determined by the signal strength at the volume limiter output, to the fixed negative bias which is on the grids of the channel and SP tubes. In addition, potentiometer SP is used to adjust the bias on the SP tube grids in order to control the sensitivity of the receiver during reception of the KP signal.

8.11 During the reception of the digit and ST signals, the variable bias circuit places variable negative bias on the grids of the channel tubes but not on the grids of tube SP. The variable negative bias is large for strong input signals and small for weak signals; it prevents the tube from conducting in unwanted channels, since a strong positive signal from the channel rectifier must overcome both the variable negative bias and the fixed negative bias.

8.12 Each receiving channel (there are six) consists of a filter, half of a vacuum tube connected as a diode rectifier, a thyratron, and a relay. The purpose of the receiving channel is to receive the ac current from the output limiter, rectify it to dc, and operate its associated channel relay. Voltage from the volume limiter through the OUT transformer is applied across resistors B and C in the six db transmission pad (formed by resistors A, B, and C). This pad acts as an impedance smoothing device between the varying output of the volume limiter and the input to the channel filters. It also decreases the effect that outside currents (which build up and die down in the filters) might have on the operation of relay SP (signal present).

8.13 The filters are assembled with elements for two frequencies under a common cover. Common input terminals for both filters are one and two, three is the output terminal for the lower frequency and four for the higher. Two other filter elements appearing on terminals four and five of the SP filter unit are also connected in parallel with the channel filter inputs to simulate the effect of filters immediately below the 700-cycle filter and above the 1700-cycle filter. This results in an appreciable improvement in the 700- and 1700-cycle wave shape at the output of those filters.

8.14 The start signal ST, consisting of frequencies seven and ten, is sent after all digits are transmitted. If the number of digits registered is less than the maximum number for which the register is equipped, a start signal is required to start marker seizure. If the number of digits registered is the same as the maximum number for which the register is equipped, the register starts seizure automatically and the start signal is not required. However, to simplify operating practices, the start signal is always sent.

8.15 When a multifrequency incoming register is seized, its operated ON1 relay closes battery over leads BAT1 and BAT2. Battery over lead BAT2 energizes the primary winding of relay KP (keypulse). This relay does not operate at this time because its secondary winding is energized by battery through its own winding and normal contacts, and normal contacts of relay SP and jack KP to ground. Lead BAT1 supplies battery to relays KP1 and KP2 for later operation.

8.16 When the KP frequencies (two and ten) are received, they pass through the volume limiter for either amplification or limiting, as required. The output of the volume limiter passes through pad A and the 100- and 1700-cycle filters. Channel rectifier tube A changes the output of the channel filter to a positive dc voltage.

8.17 The variable bias circuit operates in the following way when the KP signal is received. Energy from plate terminal five of tube L1 is connected via capacitor AA, resistor AC, and potentiometer BIAS to grid terminal seven of twin triode BR. This grid is biased 10 volts negative through the connection to the potentiometer formed by resistors AD and AE.

8.18 The amount of signal voltage applied to grid seven of tube BR is determined by the setting of potentiometer BIAS which is a part of the calibration procedure. The signal at the output of tube BR appears as a voltage across plate resistor AF and is applied to the voltage doubler rectifier consisting of capacitors AB and D, varistors A and B, and resistor N. The negative dc voltage derived from the rectified signal appears across resistor N and is added to the negative 18-volt fixed bias derived from the potentiometer formed by resistors D, E, and F. This negative voltage is connected through one-megohm resistors BA and BB to a point in each channel at the output of the channel rectifier tube. Here the negative voltage is applied to the grid of channel thyratrons for channels two and ten and to the suppressor and control grids of tube SP. During the reception of the KP signal, relay LK is normal and the positive 130 volts on the make contacts of relay LK is not placed on the plates of the thyatron tubes. Thus no conduction takes place in thyratrons for channels two and ten because of the absence of plate voltage.

8.19 Both the positive voltage from the rectifier tubes in channels two and ten and the negative voltage from the fixed and variable bias circuits appear on the grids of tube SP. Tube SP has a characteristic such that it conducts when both the grid and suppressor elements approach a positive voltage. Thus, as the grid is connected to the output of channel two and the suppressor is connected to the output of channel ten, the positive rectified signals overcome the negative bias present on these two tube elements. With both elements positive or nearly positive, the resultant plate current operates relay SP. This removes ground from the contact seven of relay KP and connects ground to lead J to the MF incoming sender circuit. In the register, the J and L leads are connected together so that the operation of relay SP operates relay LK, which supplies plate battery to all thyratrons except two and ten.

8.20 Relay KP, which was held on its back contacts from battery through the secondary winding to ground on the back contact of relay SP, remains in this condition for approximately 50 to 55 milliseconds after relay SP operates. This is because of the charging current through capacitors E, F, and G to ground at resistor K. At the end of this interval, the current in the secondary winding has decreased to such an extent that the primary winding takes control and operates relay KP to its front contacts. Relay KP remains operated to its front contacts while the digits are received.

8.21 If a third frequency accompanies the KP signal, a positive voltage is placed on a channel thyatron grid for a channel other than two and ten. This thyatron immediately becomes conducting, thereby operating its associated channel relay. Ground from the contact of this channel relay, via a back contact of relay KP2, stops the timing capacitor from charging and holds relay KP to its back contacts. Thus, no recognition takes place.

8.22 At the end of a normal KP signal, consisting only of 1100- and 1700-cycle frequencies, and lasting a minimum of 55 milliseconds, tube SP again becomes nonconducting and relay SP releases. The normal SP relay releases relay LK and again connects ground through the front contacts of relay KP to operate relays KP1 and KP2.

8.23 The operation of relays KP1 and KP2 at the end of the KP signal conditions the receiver for the receipt of digit signals by the following changes.

(a) In the SP circuit, the high negative voltage on grid three of tube BR is removed. Also, the cathode output circuit of this tube is connected to the grid and suppressor elements of tube SP. At the same time, these elements are disconnected from the filter outputs of channels two and ten.

(b) The plates of channel thyatrons two and ten are connected via their associated relays and resistors to the contacts of relay LK. When relay LK is reoperated, 130 volts are connected to the plates of all thyatrons so that subsequent operation is the same in all channels.

(c) The circuit shunting the windings of relays CK2 and CK3 is opened so that the plate current of all thyatrons in a conducting condition flows through these windings.

8.24 On this call, the first digit transmitted is a five. Therefore, 900- and 1300-cycle frequencies are sent to the receiving circuit where they traverse the input circuit and the volume limiter in the same way as described for the KP signal.

8.25 At the output of the volume limiter, the voltage across the 600-ohm resistor in the shunt element of the six-db pad is applied through band-pass filter SP and input transformer SP to grid terminal three of tube BR. This voltage is rectified, and the resulting dc voltage is taken from cathode terminal two of tube BR and applied through the smoothing filter (consisting of capacitors C and H and resistor P) and the make contacts of relay KP2 to the grid and suppressor elements of tube SP. After fourteen milliseconds, capacitor H becomes sufficiently charged so that the current flow in the plate circuit of tube SP operates relay SP which operates relay LK. The operation of relay LK connects 130-volt battery to the plate circuits of all six channel thyatrons.

8.26 Part of the energy from the digit five signal is taken from the plate of tube 1L for the operation of the variable bias circuit. The ac voltage from tube 1L is connected to grid terminal seven of tube BR, is amplified, and is passed to a rectifier circuit. The negative dc voltage derived from the rectifier is added to the negative 18-volt bias on the grids of the thyratrons.

8.27 The ac voltage across resistors B and C in the six-db pad is applied to the rectifier tubes of channels one and four through the 900- and 1300-cycle filters. The rectified positive voltage is added to the 18-volt fixed negative bias increased by the negative voltage controlled by the incoming signal amplitude. It is then applied to the grid terminals of the thyratrons for channels one and four. With the incoming signal voltage on the grid terminals of the thyratrons for channels one and four and with battery on the plate terminals of all thyratrons, tubes B and C (for channels one and four) the two thyratrons conduct. The operation of relay CK2 results in the following actions:

- (a) Removes ground from resistor F, increasing the fixed bias on the thyatron grids from -18 to -48 volts to insure that no other channel thyratrons conduct from the end transient condition when the signal ceases.
- (b) Connects ground to lead H.
- (c) Places a second ground on leads J and Q. This ground is independent of relay SP.

8.28 When the register was first seized, the register relay AS (A digit steering) operated. Receiver relay CK2 operates the register relay RA which operates relay BS (B-digit steering). The channel relays one and four ground leads one and four to the register to operate counting relays A1 and A4. Register relay BS opens the J-L loop to release receiver relay LK. Relay LK opens the 130-volt lead, causing relay CK2 and the channel thyratrons to release. Relay CK2 releases register relay RA which releases relay AS. When the channel thyratrons stop conducting, the channel relays release.

8.29 The end of the signal for the A digit causes tubes BR and SP to stop conducting. Varistors C, D, and E in the SP circuit are poled so as to reduce the time constant of resistor P and capacitor H at the end of the signal. While the first digit is being received, relay CK3 operates if three thyatron tubes conduct current because of the presence of a third frequency. When relay CK3 operates, it removes ground from lead K to the register and grounds lead R0 to the register. The grounded R0 lead operates relay R0 and the call is routed to reorder. The B digit and the succeeding digits are detected by the receiver and then registered by the operation of their respective register relays in the same manner as described for the first digit. After all the digits have been transmitted, the ST (start signal) signal, consisting of frequencies seven and ten, is sent. The receiver functions in the same way as on digit pulses, except it grounds the seven and ten leads.

9. Marker Start-Dial Pulse and Multifrequency Incoming Registers

General

9.01 Where impulsing is completed, the incoming register calls for a completing marker. It gives the marker all the information it has received. This includes:

Registered Digits

Trunk Link Frame Number of Incoming Trunk

Class of Incoming Trunk

Directory Number of Incoming Trunk (for Tandem and Toll Class Trunks with line link frame appearances)

The completing marker establishes a connection from the trunk link frame appearance of the incoming trunk to the line link frame appearance of the called subscriber's line. It makes the usual tests and then disconnects.

9.02 OS 740-1 shows some typical cross connections for marker start with different trunk classes and varying numbers of digits in a multifrequency incoming register. The cross connections represent trunks which would serve the offices shown in the block diagram on OS 734-1.

9.03 OS 739-1 shows typical cross connections for marker start in dial pulse incoming registers. Examples using stations delay and various trunk classes are shown.

10. Incoming Register Connects to a Marker

10.01 An incoming register selects an idle marker in the same manner as an originating register does in the terminating stage of an intraoffice call. This is described in Section 5 - Intraoffice Calls. OS 701-2 illustrates the circuit arrangement.

10.02 The trunk link frame number is passed from the incoming register link to the incoming register where it is recorded. When an incoming register marker connector is selected, its RS- (register start) relay (OS 701-2) is operated by the incoming register. The operated RS- relay prepares a path to operate the marker connector RA (register connector) and MA (marker connector) relays. The operated RA and MA relays close a path to operate marker relays FGO or FGL (trunk frame group) and TF- (trunk frame) (OS 736-1). Relay FGO represents a frame in trunk frame group 0 through 9, and relay FGL represents a frame in trunk frame group 10 through 19. The TF- relays operate on a two-out-of-five code basis. For example, if the selected trunk is located on trunk link frame 10, relays FGL, TF4, and TF7 in the marker are operated.

10.03 The operated marker connector RS relay also prepares a path to operate the marker connector RB, RC, RD, RE (register connector) MB, MC, MD and ME (marker connector) relays (OS 701-2). These relays close a path from the incoming register, where the class information was recorded, to the class relays in the marker (OS 734-1).

10.04 The operated marker connector and relays also close paths to operate marker code register relays AC $\frac{2}{5}$, and BC $\frac{2}{5}$, CC and the INC (incoming) relays (OS 715-1). Relay INC indicates to the marker that the call terminates in this office.

10.05 An office consisting of one 10,000-directory number series requires no office identification. The called numerals identify the called line. The incoming register operates marker relay OA (office A), which

operates relay N1 to prepare paths for operating the marker registration relays (OS 734-1). An office consisting of two 10,000-directory number series requires office identification in addition to the numerals of the called line to identify the called line. If this office is provided with one group of incoming trunks serving one 10,000-directory number series and another group of incoming trunks serving the other 10,000-directory number series, the incoming register will operate either relay OA (Office A) or OB (Office B). However, if the same group of incoming trunks has access to both directory number series, an office identifying digit is received from the calling office and passed from the incoming register to the marker. The office identifying digit precedes the numerical digits and identifies the office directory number series as office A or B.

The office identifying digit is recorded on relays AC $\frac{2}{5}$, (A digit code) on a two-out-of-five code basis. Relays OA and OB do not operate.

10.06 OS 734-1 has a block diagram which illustrates examples where separate trunk groups, five, six and seven digit trunk groups are used.

10.07 The circuit arrangement for an office equipped to handle four, five, or seven digit calls is shown on OS 720-1. On a four digit call, relays AG $\frac{2}{5}$, BC $\frac{2}{5}$, and CC $\frac{2}{5}$ are used to prepare a path to the marker numerical digit registration relays (TH-, HN-, and T-). On a four digit call requiring an office identification digit, the office digit is recorded on relays AC $\frac{2}{5}$. Relays BC $\frac{2}{5}$ (B digit code) and CC $\frac{2}{5}$ (C digit code) are used to prepare a path to marker registration relays TH- and HN-.

10.08 If an office identification digit is required in addition to the called line numerals, the incoming register grounds marker punching FVD (OS 734-1). This ground operates relay FVD (translator control, 5 digits). The register also operates two of the five AC- relays in the marker (OS 715-1). Relays FVD and AC $\frac{2}{5}$, ground a code point to operate the LPA, LTA, LEA, LPB, LTB, or LEB (local physical, local theoretical, or local extheo office A or B) relay (OS 716-1).

11. Trunk Link Frame Seizure

11.01 Each trunk link frame has an MP- (marker preference) relay associated with each marker (OS 702-2). All markers in an office have access to each trunk link frame, but only one marker at a time can connect to a trunk link frame. If the trunk link frame to be used on a call is engaged by one marker, the second marker must wait until the trunk link frame becomes idle. This is controlled by the MP- relay chain.

11.02 When a marker seizes a trunk link, it operates its associated MP- relay for that trunk link frame. A trunk link frame seizure on an incoming call, is indicated by the operated marker TFK3 (trunk frame check) relay. Relay TFK3 checks that the selected trunk link frame MP- relay associated with this marker is operated and all other more preferred MP- relays in the same trunk link are not operated.

11.03 On an incoming call, the marker is directed to seize the trunk link frame on which the incoming trunk is located. The marker does not choose a trunk link frame as it does on other calls. The operated frame group (FG $\frac{0}{1}$) and trunk frame units (TF $\frac{2}{5}$) relays establish a path over which the marker seizes the proper trunk link frame.

12. Trunk Link Frame - Link Connector and Select Magnet Operation

12.01 Link Connector Operation: Marker relay TFK3 closes battery through the incoming register marker connector and incoming register link circuits to operate trunk relay F. This path is on SD-26002-01, FS33. Relay F operates relay FB-- (B appearance trunk connector). Relay FB-- operates relay LC- (link connector). One LC- connects the twenty links of the associated switch to the marker. Ten of these links are connected through by relay R (right); the other ten by relay L (left). Therefore, only ten links are connected through for channel test.

12.02 Select Magnet Operation: The operation of the select magnets is similar to the operation of the select magnets for setting up the connecting path to the calling line on intraoffice connection (Section 5). However, instead of operating the trunk link frame trunk switch select magnet A, select magnet B is operated through contacts of the operated marker FBK (frame B appearance check) relay. This is because an incoming trunk is always associated with the B appearance on the trunk link frame.

13. Priming the Incoming Trunk for Charging

13.01 On full selector calls requiring charging and on manual, dial switchboard A operator, and toll operator calls, the marker sets the incoming trunk for a charge condition. When the marker LI (line idle) relay (OS 725-1) operates, trunk relay TC (talking charge) is operated through the primary winding of the TCK (talking charge check) relay. Polar relay TCK does not operate at this time. Trunk relay TC locks and returns ground to the marker which operates relay TCK. This checks the operation of trunk relay TC.

14. Marker Selects Number Group to Locate Called Line

14.01 The number group is selected by the marker in a manner similar to that described for intraoffice calls (Section 5).

15. Number Group Locates Called Line and Transfers Information to the Marker

15.01 Number group translation and transfer of called line information are identical to that described for intraoffice calls (Section 5).

16. Releasing the Number Group

16.01 Number group release is similar to that described for intraoffice calls (Section 5).

17. Selecting the Line Link Frame

17.01 Line link frame selection is similar to that described for intraoffice calls (Section 5).

18. Operating the Called Line Identification Relays

18.01 Operation of the called line identification relays is similar to that described for intraoffice calls (Section 5).

19. Number Group Makes Ringing Selection

19.01 Ringing selection is made in a manner similar to that described for intraoffice calls (Section 5).

20. Junctor Control, Channel Test, and Channel Selection

20.01 Junctor control, channel test, and channel selection are similar to that described for the intraoffice call (Section 5).

21. Operating the Select and Hold Magnets

21.01 After a channel is selected, the various select and hold magnets are operated. This operation is the same as that described for the intraoffice call (Section 5).

22. False Cross and Ground and Continuity Tests

22.01 These tests are made in a manner similar to those for the intraoffice call, Section 5. After the operation of all the crosspoints except the line hold magnet, the false cross and ground test is made. If successful, the line hold magnet is operated and a continuity test is applied. The marker has been informed by the number group whether the called party is a tip or ring party, therefore, in the continuity test, the test relay is applied to the proper side of the line.

23. Ground, Loop and Receiver Off-Hook Tests

23.01 These tests are made in a manner similar to that described for intraoffice calls, Section 5.

24. Sleeve Double Connection Test and Holding Ground Check

24.01 Sleeve double connection test and holding ground check are similar to those described for the intraoffice call, Section 5.

25. Releasing the Select Magnets

25.01 After the operation of DCT (double connection test) relay indicating a successful double connection test, relay DCT1 (double connection test) operates. This releases the ONX (off-normal cross) relay which releases the select magnets.

26. Marker and Register Release

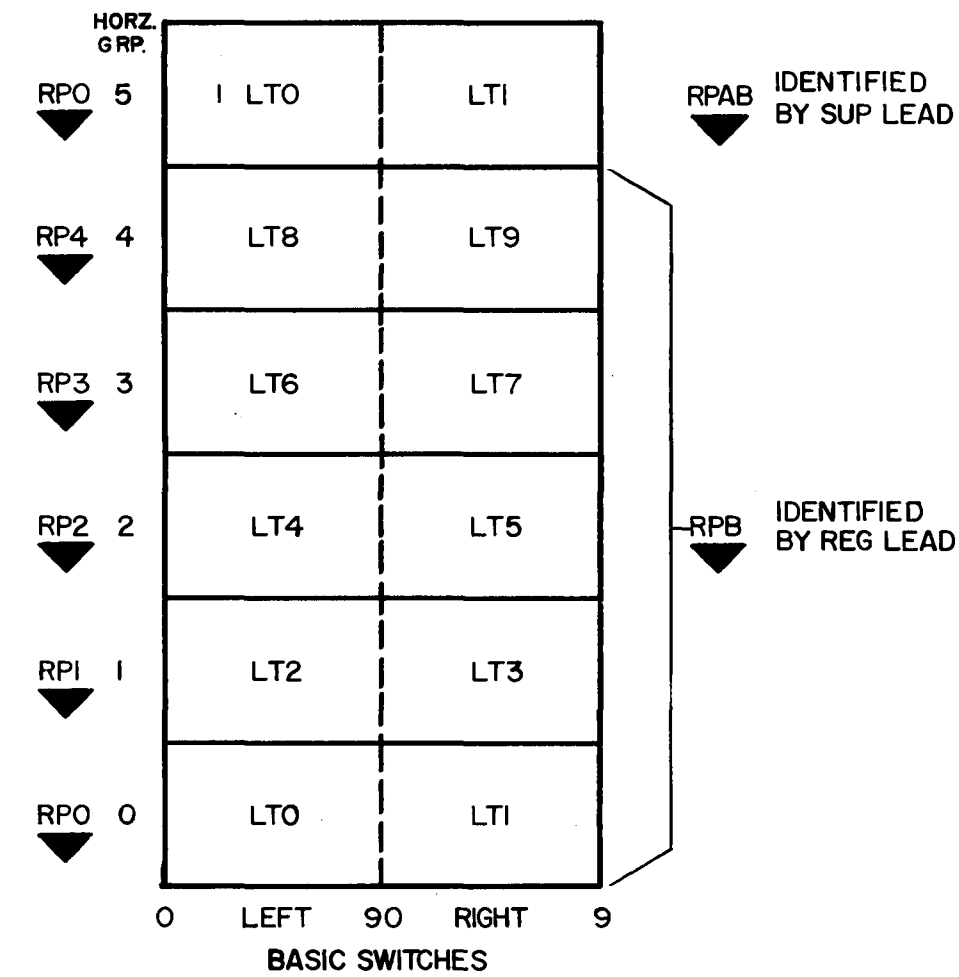
26.01 When the tests and checks described above are completed, relay DCT releases. Relay DCT operates the LK1 (linkage check) relay. Relay LK1 indicates a completion of the incoming trunk connection. Relay LK1 also operates the DIS1 and DIS2 (disconnect) relays. This causes the line link, trunk link, incoming register, and marker to release.

27. Ringing and Disconnect

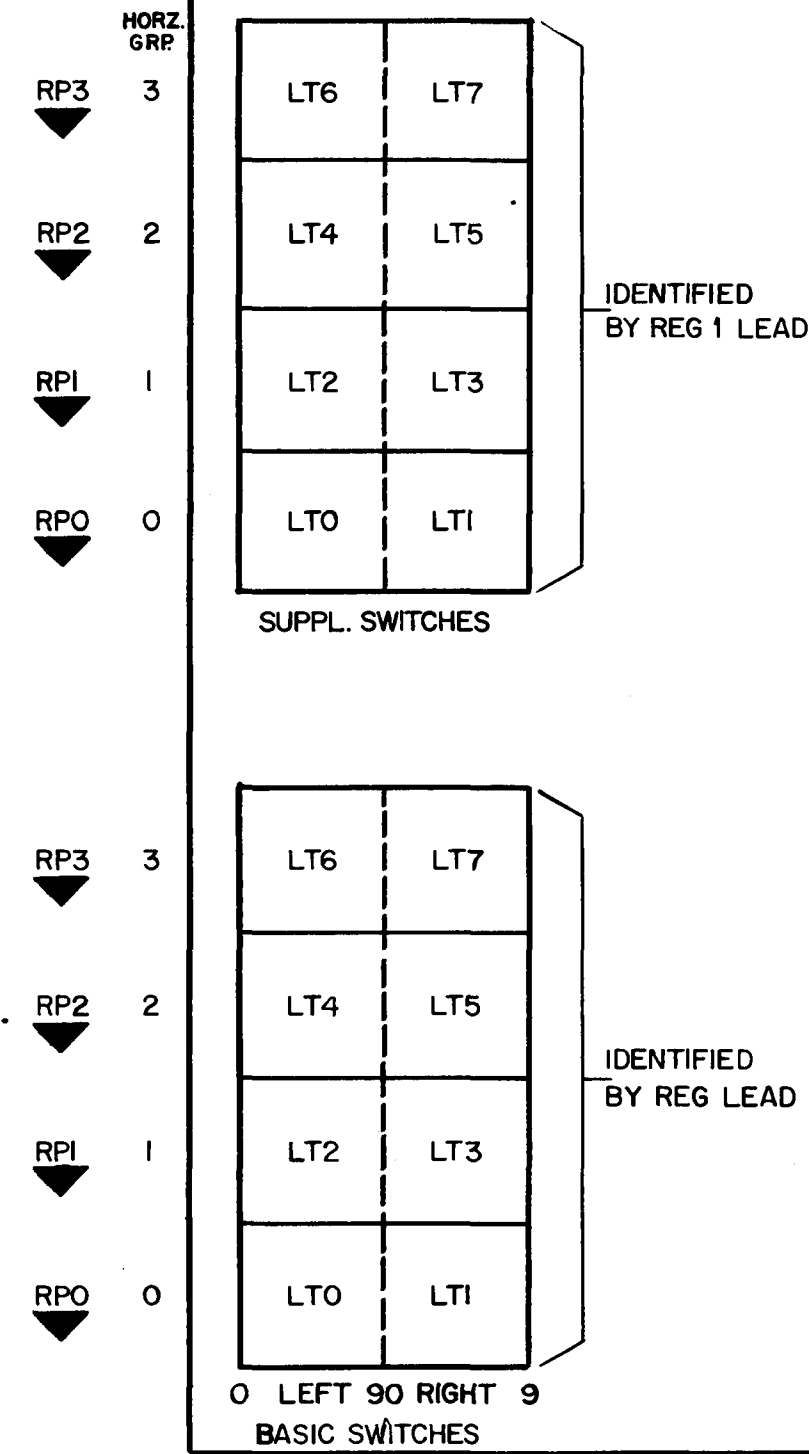
27.01 Release of trunk link relay FB--, after marker double connection test, transfers the tip and ring from the marker to the trunk and return control of the ringing selection switch hold magnet to the trunk circuit. Ringing of the called party now starts. When the called party answers, ringing is tripped.

DIAL PULSE INCOMING REGISTER LINKS

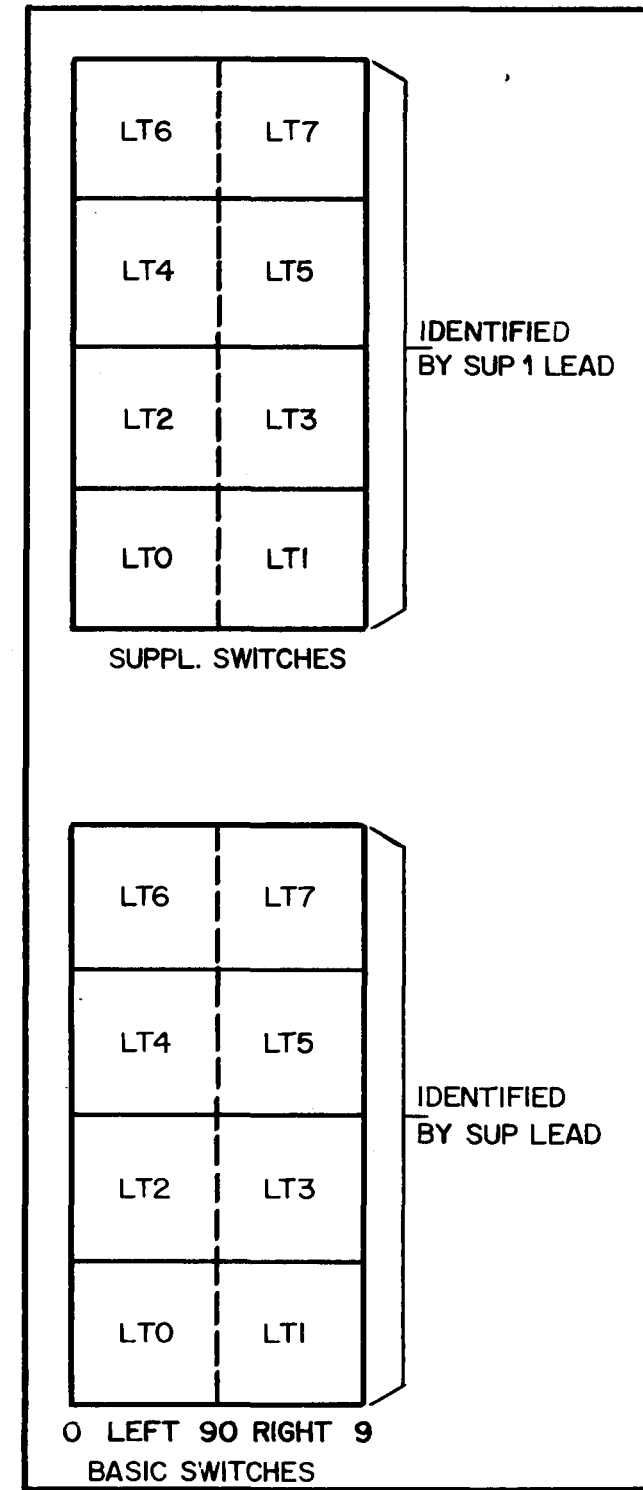
MAXIMUM SIZE IRL WHEN ANY TRUNKS ARE BY-LINK.
CAPACITY 120 TRUNKS, 100 WITH LINE LINK FRAME APPEARANCES.



MAXIMUM SIZE IRL WHEN ALL TRUNKS ARE DIRECT PULSING.
CAPACITY 320 TRUNKS, 160 WITH LINE LINK FRAME APPEARANCES.



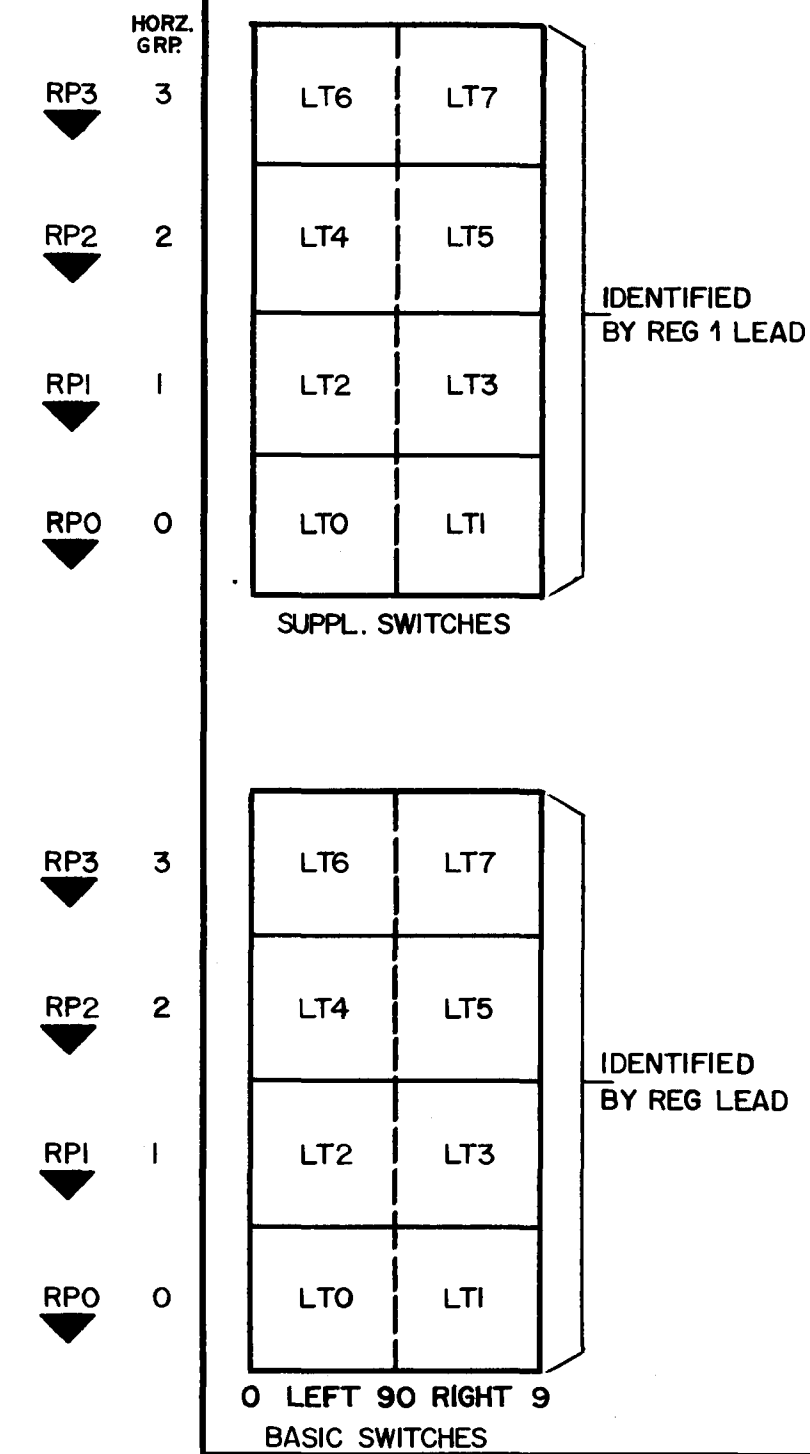
1ST FRAME
TROUBLE CARD PUNCH RPB



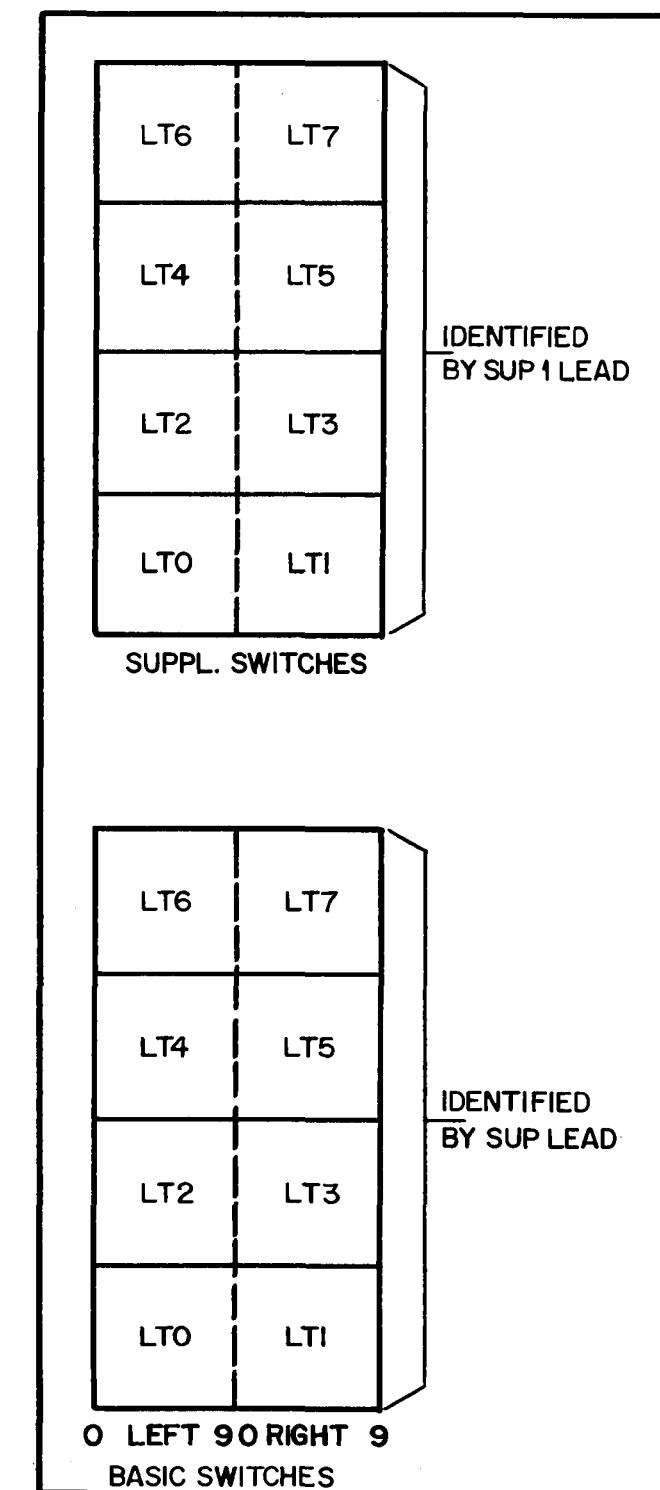
2ND FRAME
TROUBLE CARD PUNCH RPAB

MULTIFREQUENCY INCOMING REGISTER LINKS

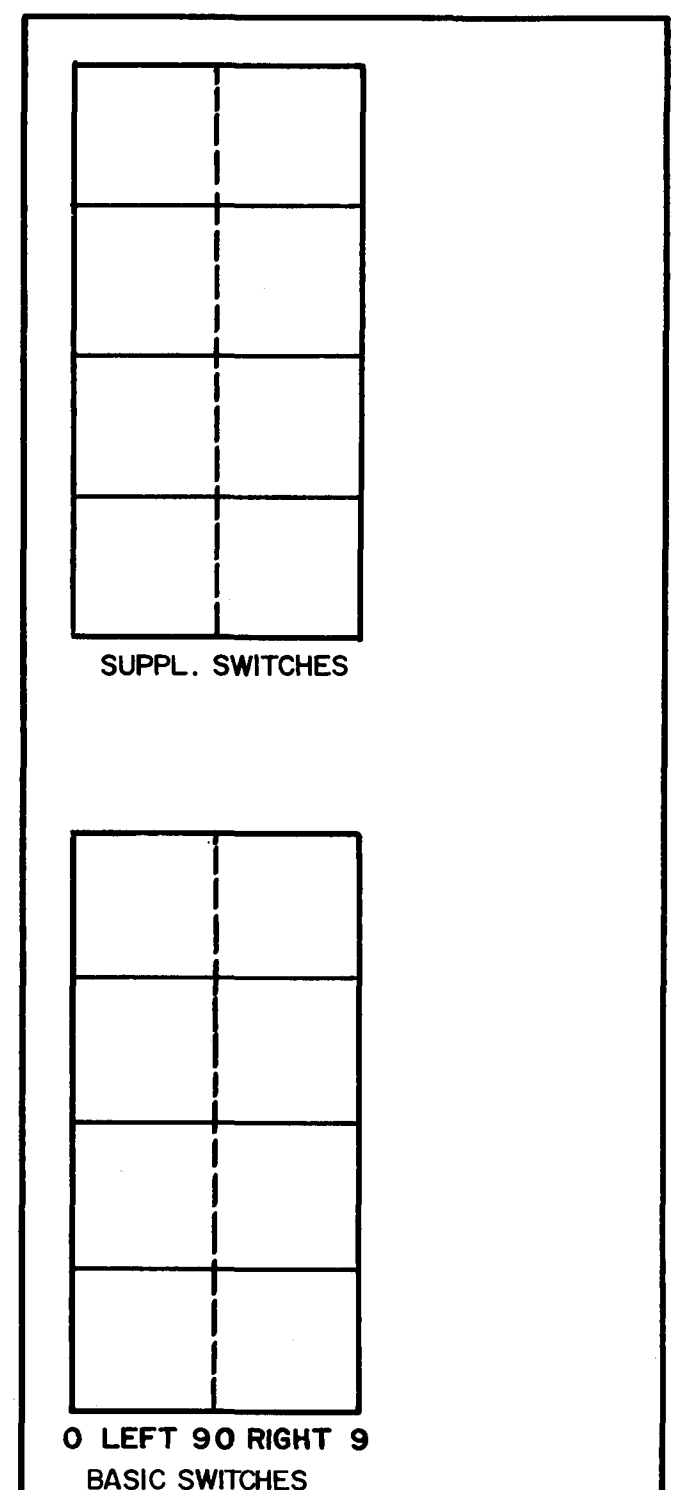
MAXIMUM SIZE IRL. 480 TRUNKS, 320 WITH LINE LINK FRAME APPEARANCES.



1ST FRAME
TROUBLE CARD PUNCH RPB



2ND FRAME
TROUBLE CARD PUNCH RPAB



3RD FRAME
TROUBLE CARD PUNCH RPSA

FIG.1 INCOMING REGISTER LINK ARRANGEMENTS

